US009465335B2

(12) **United States Patent**
Sato

(10) **Patent No.: US 9,465,335 B2**
(45) **Date of Patent: Oct. 11, 2016**

(54) **IMAGE FORMATION APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/692,782**

(22) Filed: **Apr. 22, 2015**

(65) **Prior Publication Data**

US 2015/0309456 A1 Oct. 29, 2015

(30) **Foreign Application Priority Data**

Apr. 23, 2014 (JP) 2014-089125

(51) **Int. Cl.**
G03G 15/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/2039*** (2013.01); *G03G 15/205* (2013.01); *G03G 15/2042* (2013.01); *G03G 15/2046* (2013.01); *G03G 15/2082* (2013.01); *G03G 2215/00734* (2013.01)

(58) **Field of Classification Search**
CPC G03G 2215/00734; G03G 15/2039; G03G 15/2046; G03G 15/205
USPC 399/69
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,682,577	A *	10/1997	Kiyoi	G03G 15/2039	219/494
8,731,429	B2 *	5/2014	Asami	G03G 15/2042	399/329
2008/0240748	A1 *	10/2008	Kinouchi	G03G 15/2039	399/33
2012/0051766	A1 *	3/2012	Ueno	G03G 15/205	399/45
2013/0136479	A1 *	5/2013	Yuasa	G03G 15/2046	399/69
2014/0294418	A1 *	10/2014	Sato	G03G 15/2042	399/69

FOREIGN PATENT DOCUMENTS

JP	2008-249763	A	10/2008
JP	2008249763	A *	10/2008
JP	2014-194443	A	10/2014

* cited by examiner

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(57) **ABSTRACT**

An image formation apparatus includes a fixation unit supported by a support member and configured to be heated by a heater and thereby fix an image attached on a print medium onto the print medium; a first temperature detector attached to the support member to detect a temperature of a vicinity of the fixation unit and output a first detection temperature; a second temperature detector attached to the support member to detect a temperature of the support member and output a second detection temperature; a medium width detector provided to detect a width of the print medium and output a detected width; and a heat controller configured to change a control condition in accordance with the second detection temperature, a calorific value of the heater and the detected width, and to thereby control a temperature of the fixation unit.

22 Claims, 14 Drawing Sheets

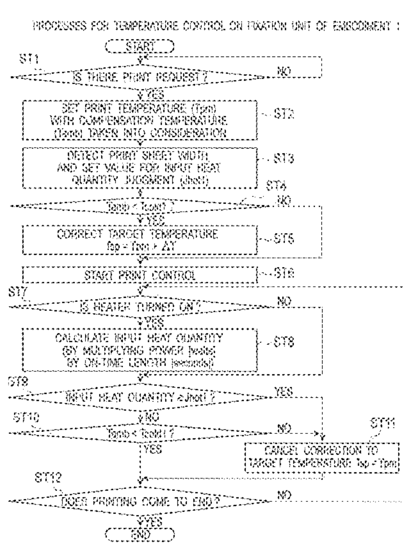


FIG. 1

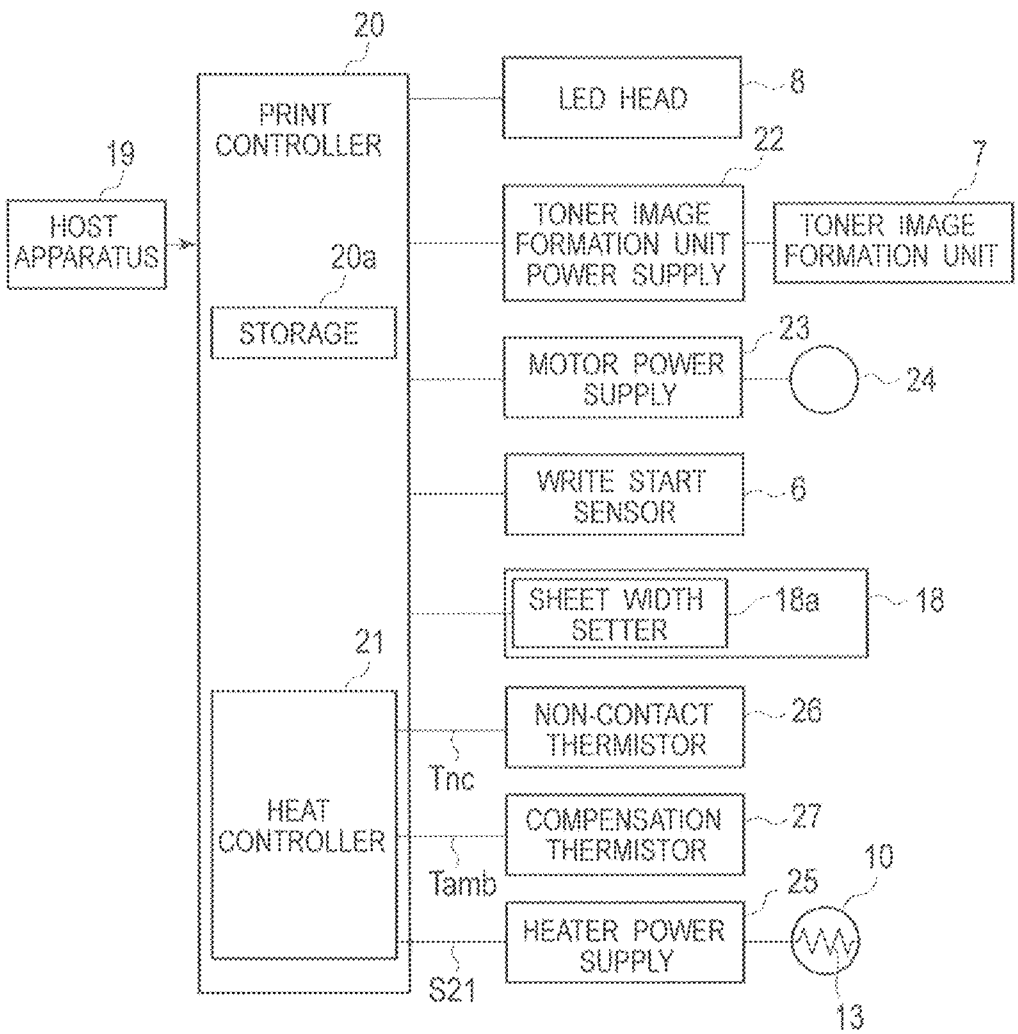

20
PRINT CONTROLLER
19
HOST APPARATUS
20a
STORAGE
21
HEAT CONTROLLER
LED HEAD
8
22
TONER IMAGE FORMATION UNIT POWER SUPPLY
7
TONER IMAGE FORMATION UNIT
23
MOTOR POWER SUPPLY
24
WRITE START SENSOR
6
SHEET WIDTH SETTER
18a
18
NON-CONTACT THERMISTOR
26
Tnc
COMPENSATION THERMISTOR
27
Tamb
10
25
HEATER POWER SUPPLY
S21
13

FIG. 2

IMAGE FORMATION APPARATUS OF EMBODIMENT 1

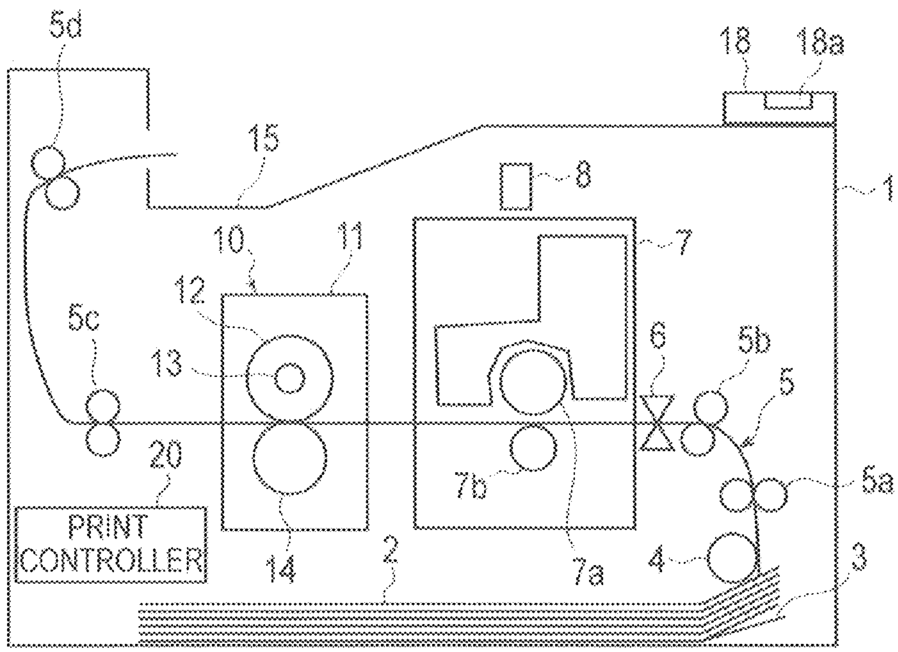


FIG. 3

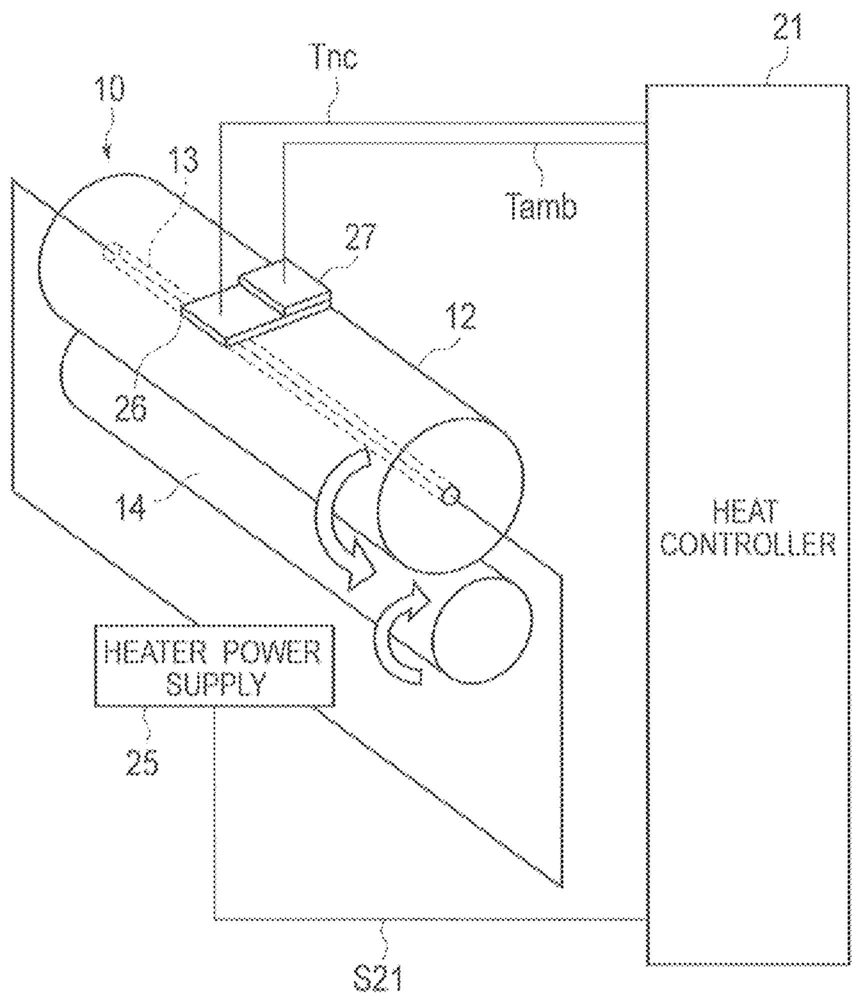

21
Tnc
10
13
Tamb
27
12
26
14
HEAT
CONTROLLER
HEATER POWER
SUPPLY
25
S21

FIG. 4A

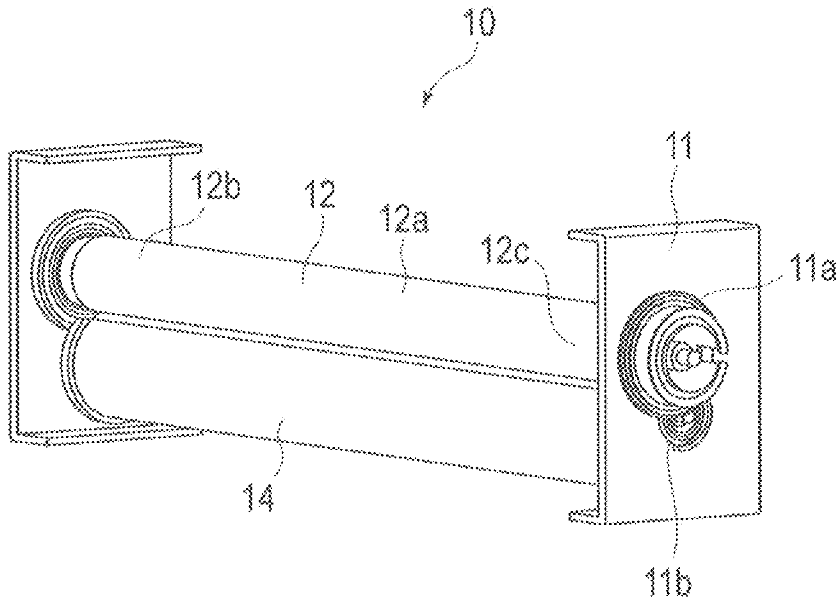


FIG. 4B

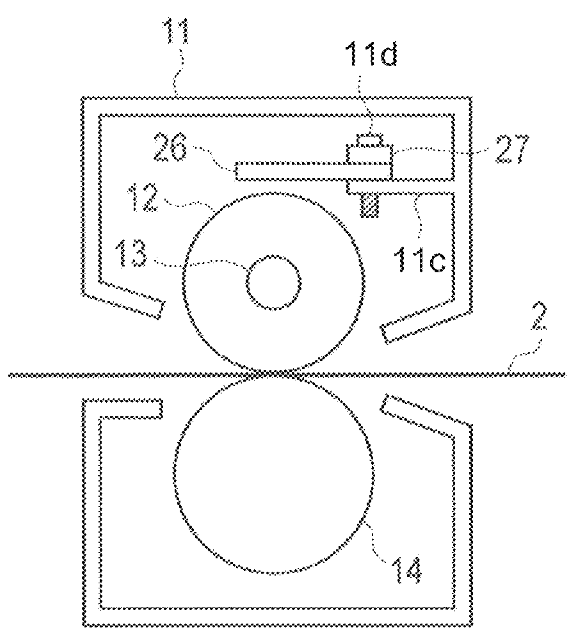


FIG. 5A

FIG. 5B

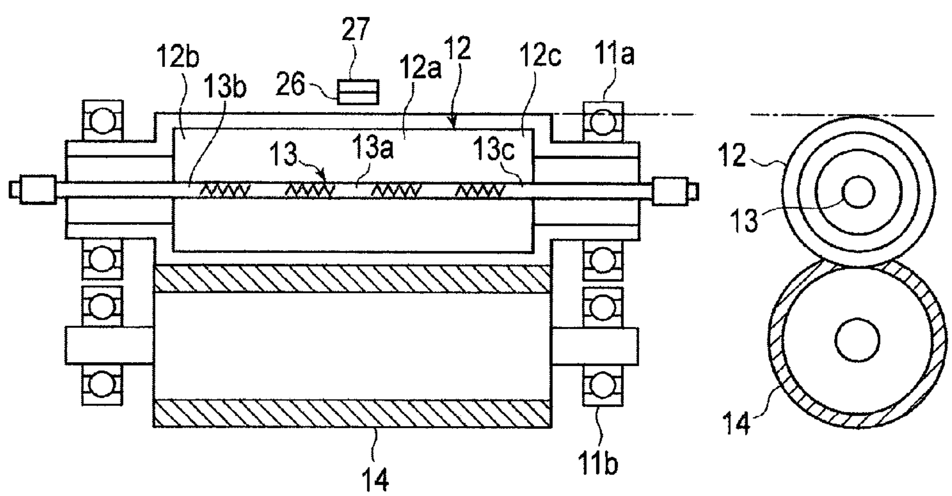


FIG. 5C

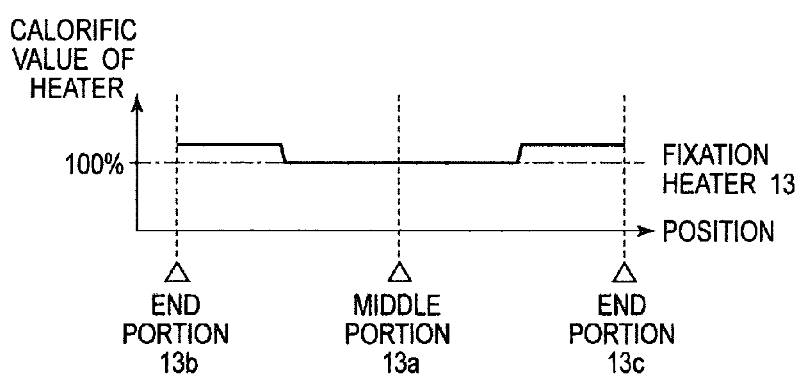


FIG. 6A

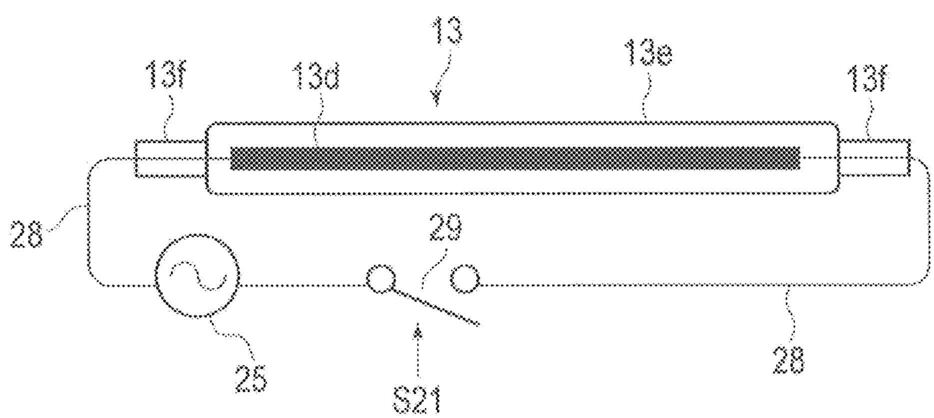

13
13f
13d
13e
13f
28
29
25
S21
28

FIG. 6B

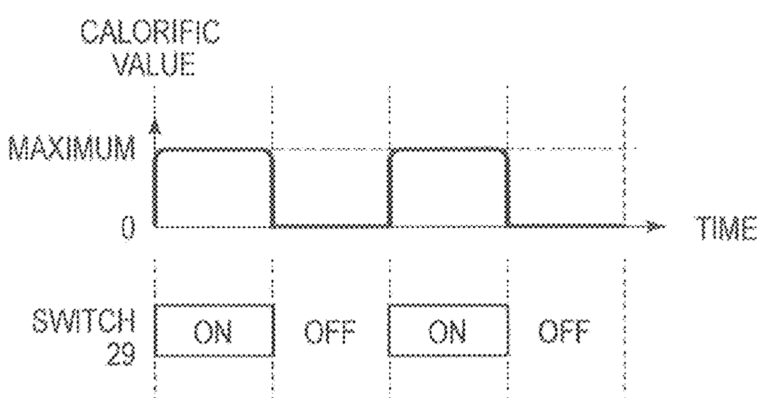
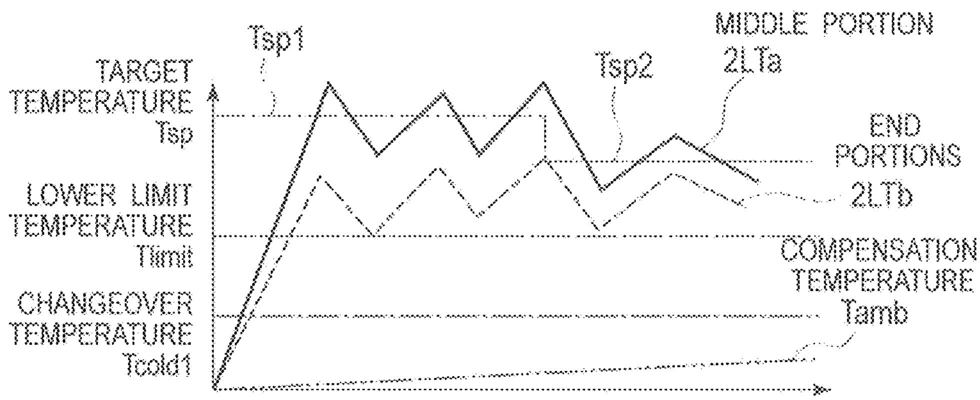

CALORIFIC VALUE
MAXIMUM
0
TIME
SWITCH 29
ON
OFF
ON
OFF

FIG. 7A

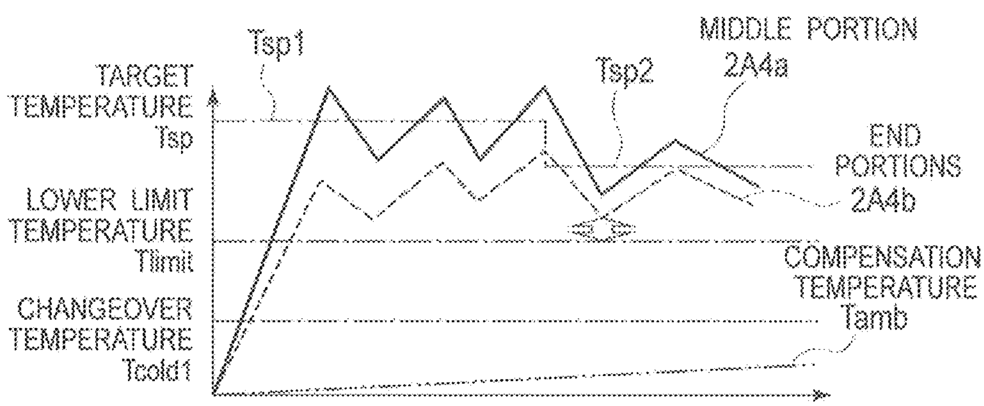
TEMPERATURE CONTROL AND TEMPERATURE CHANGES ON FIXATION UNIT OF COMPARATIVE EXAMPLE



CASE OF PRINTING ON LETTER-SIZE SHEETS

FIG. 7B

TEMPERATURE CONTROL AND TEMPERATURE CHANGES ON FIXATION UNIT OF COMPARATIVE EXAMPLE



CASE OF PRINTING ON A4-SIZE SHEETS

FIG. 8A

CHARACTERISTICS OF FIXATION UNIT ILLUSTRATED IN FIGS. 5A AND 5B

INPUT HEAT QUANTITY AS WELL AS TEMPERATURE DIFFERENCE BETWEEN MIDDLE PORTION AND END PORTIONS

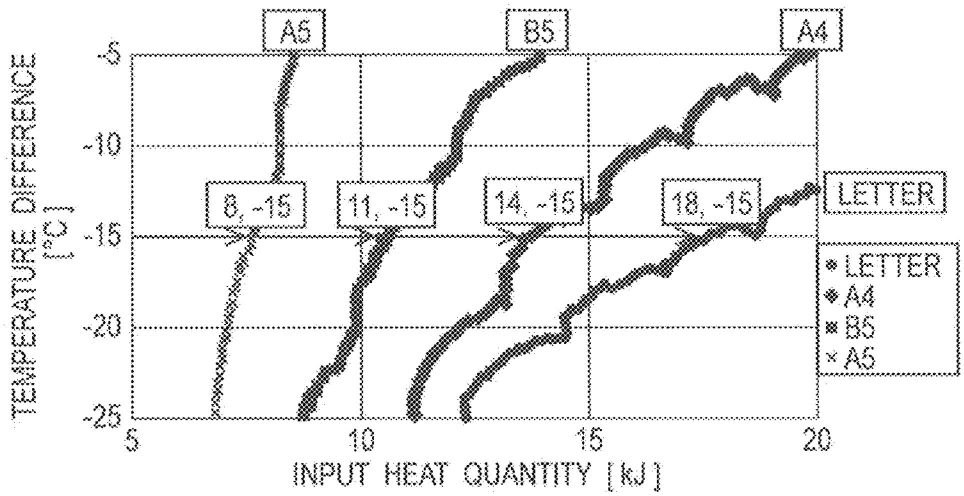


FIG. 8B

CHARACTERISTICS OF FIXATION UNIT ILLUSTRATED IN FIGS. 5A AND 5B

SHEET WIDTH AND INPUT HEAT QUANTITY MAKING TEMPERATURES OF END PORTIONS LESS THAN TEMPERATURE OF MIDDLE PORTION BY 15 °C

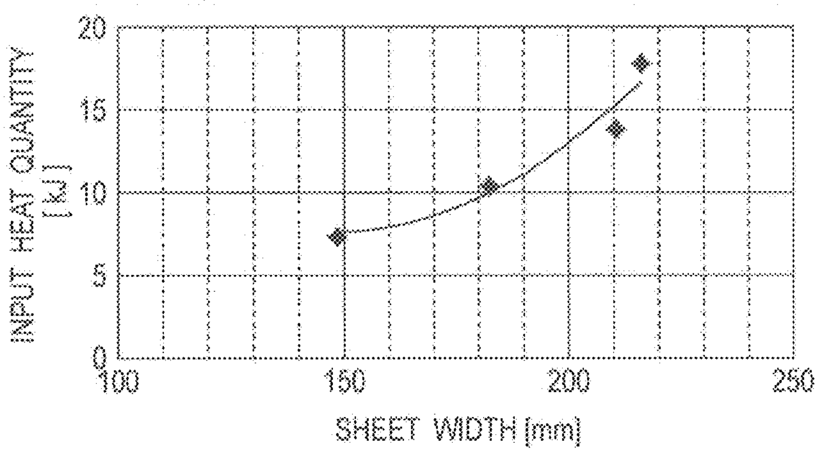


FIG. 9

PROCESSES FOR TEMPERATURE CONTROL ON FIXATION UNIT OF EMBODIMENT 1

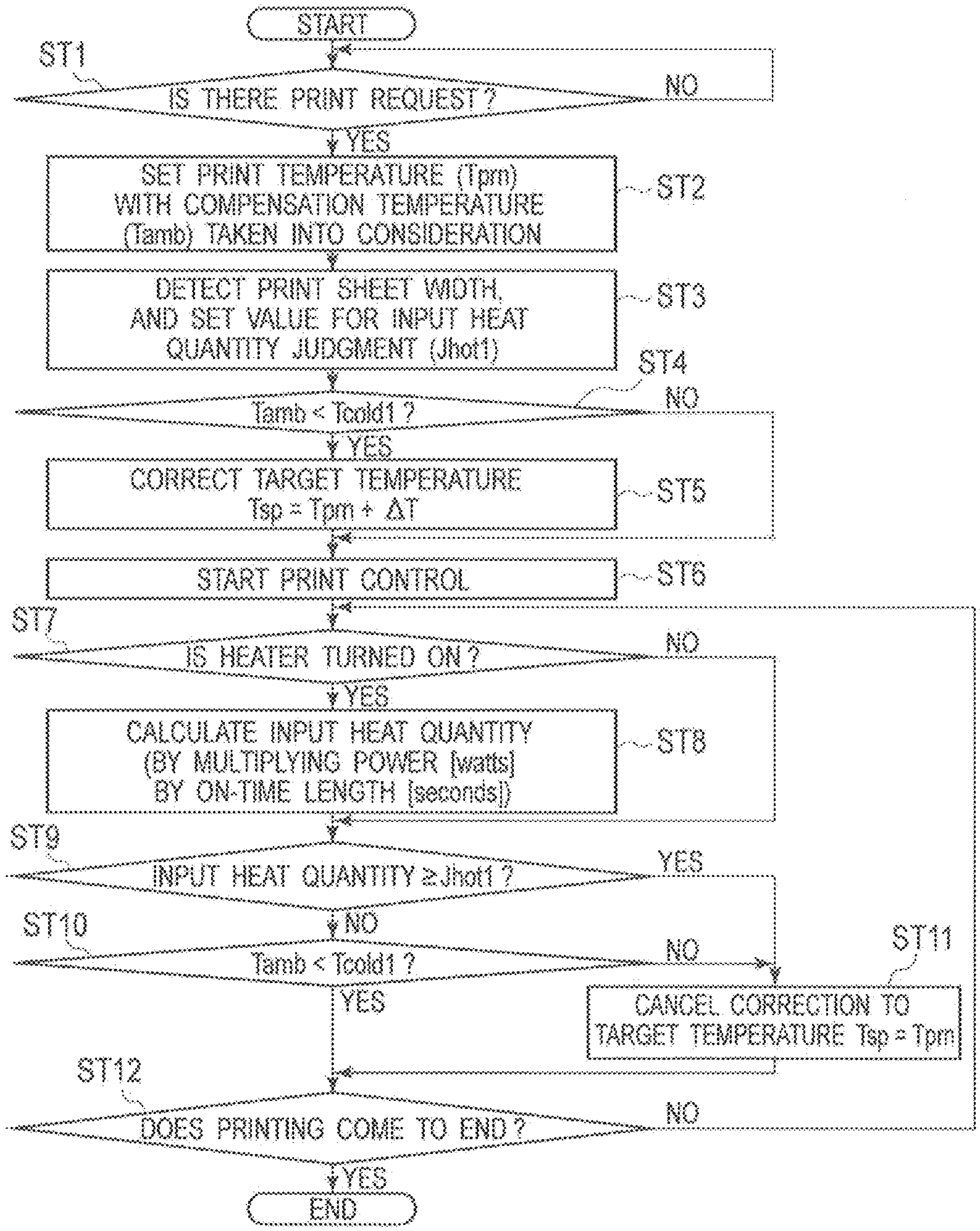


FIG. 10A

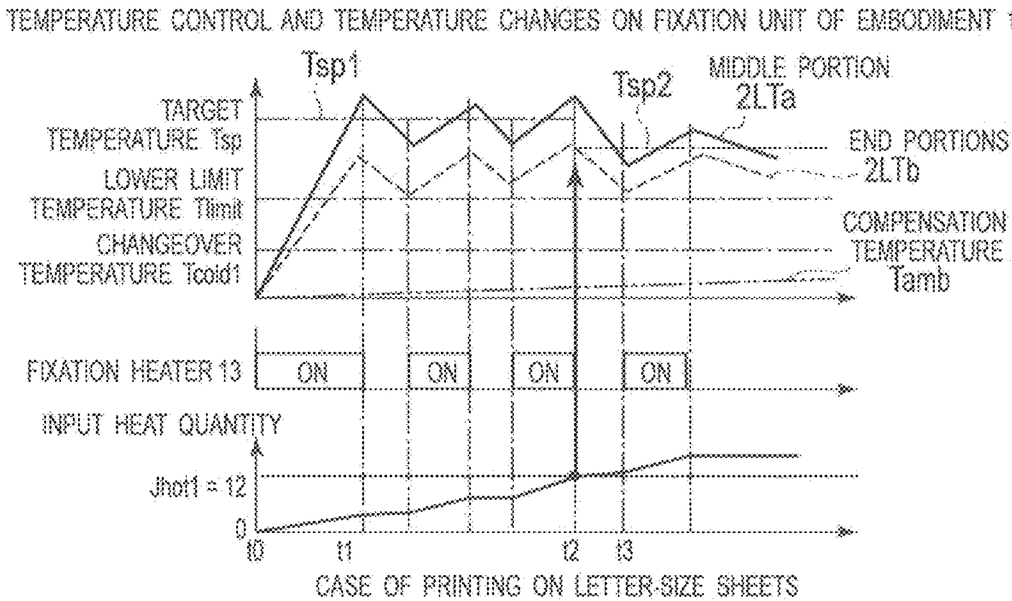


FIG. 10B

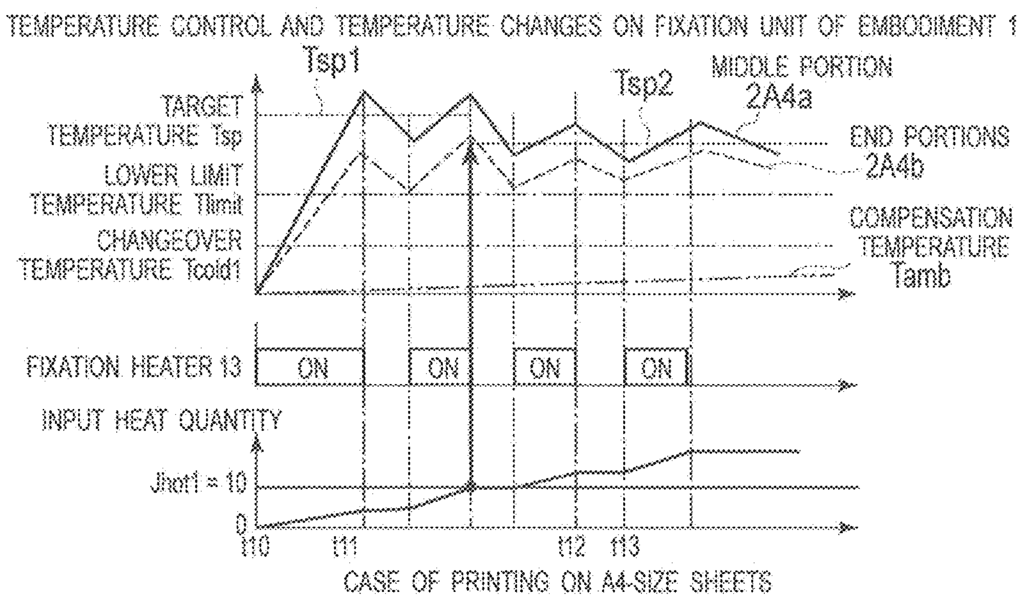


FIG. 11A

CHARACTERISTICS OF FIXATION UNIT OF EMBODIMENT 2

NUMBER OF PRINTED PRINT MEDIA AS WELL AS TEMPERATUER DIFFERENCE BETWEEN MIDDLE PORTION AND END PORTIONS

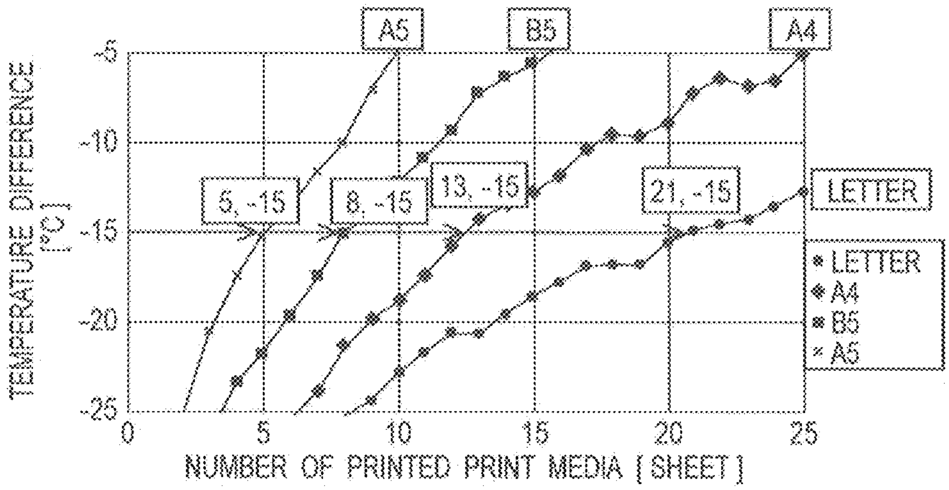


FIG. 11B

CHARACTERISTICS OF FIXATION UNIT OF EMBODIMENT 2

SHEET WIDTH AND NUMBER OF PRINTED PRINT MEDIA MAKING TEMPERATURES OF END PORTIONS LESS THAN TEMPERATURE OF MIDDLE PORTION BY 15 °C

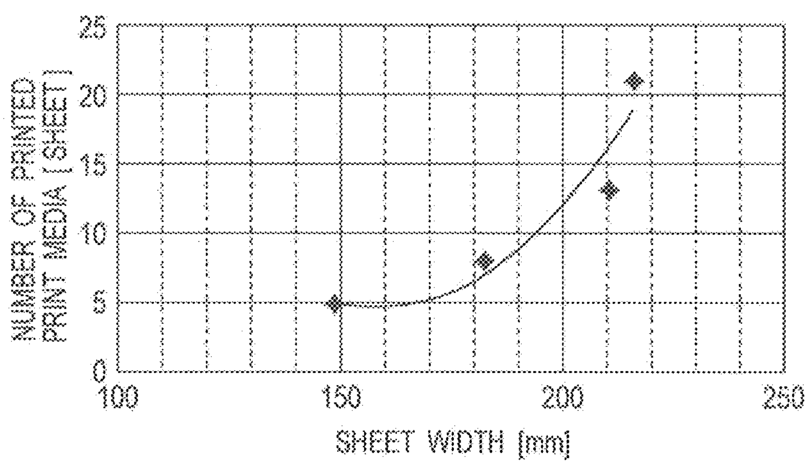


FIG. 12

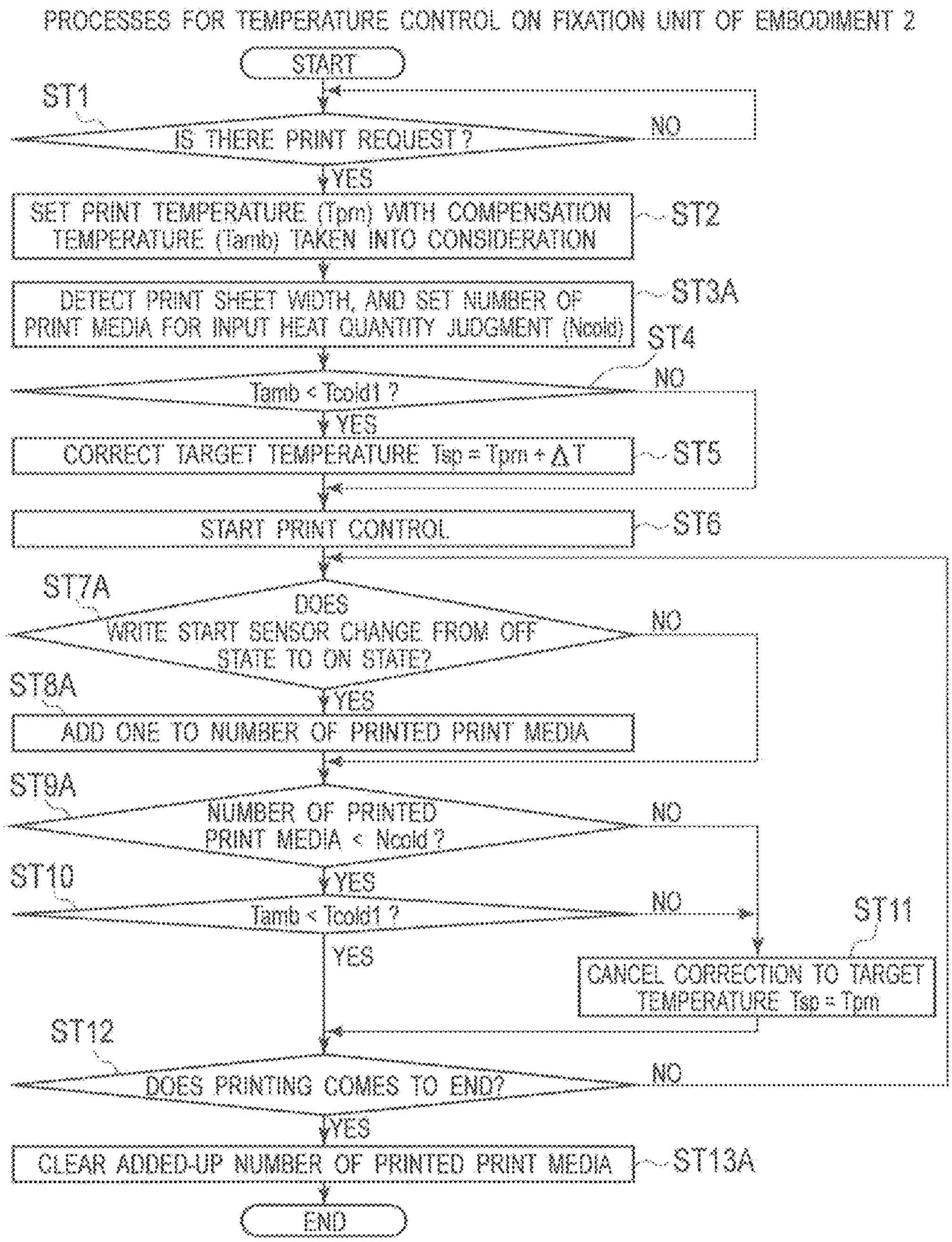
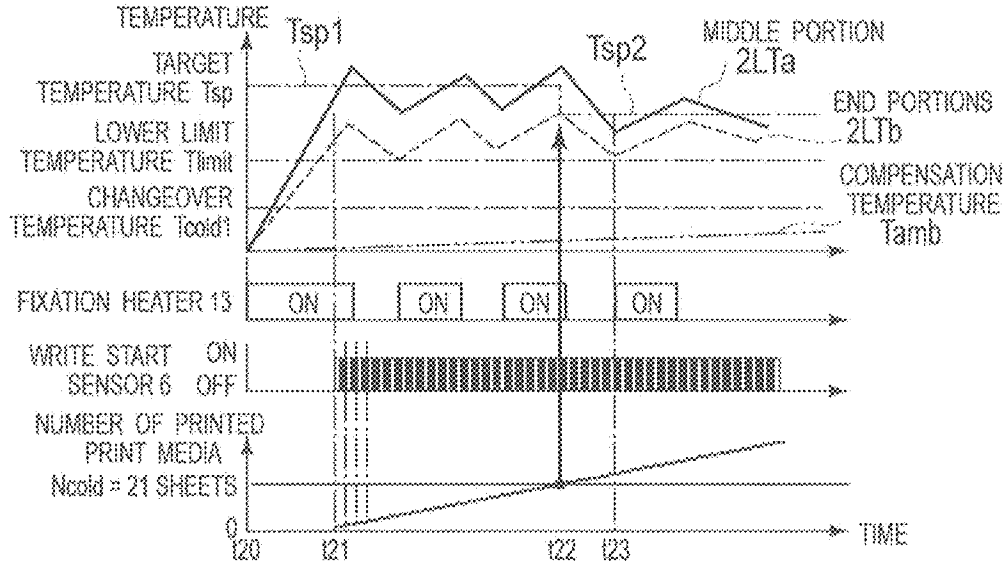

PROCESSES FOR TEMPERATURE CONTROL ON FIXATION UNIT OF EMBODIMENT 2
START
ST1
IS THERE PRINT REQUEST ?
NO
YES
SET PRINT TEMPERATURE (Tpm) WITH COMPENSATION TEMPERATURE (Tamb) TAKEN INTO CONSIDERATION
ST2
DETECT PRINT SHEET WIDTH, AND SET NUMBER OF PRINT MEDIA FOR INPUT HEAT QUANTITY JUDGMENT (Ncold)
ST3A
ST4
Tamb < Tcold1 ?
NO
YES
CORRECT TARGET TEMPERATURE Tsp = Tpm + ΔT
ST5
START PRINT CONTROL
ST6
ST7A
DOES WRITE START SENSOR CHANGE FROM OFF STATE TO ON STATE?
NO
YES
ST8A
ADD ONE TO NUMBER OF PRINTED PRINT MEDIA
ST9A
NUMBER OF PRINTED PRINT MEDIA < Ncold ?
NO
YES
ST10
Tamb < Tcold1 ?
NO
YES
ST11
CANCEL CORRECTION TO TARGET TEMPERATURE Tsp = Tpm
ST12
DOES PRINTING COMES TO END?
NO
YES
CLEAR ADDED-UP NUMBER OF PRINTED PRINT MEDIA
ST13A
END

FIG. 13A

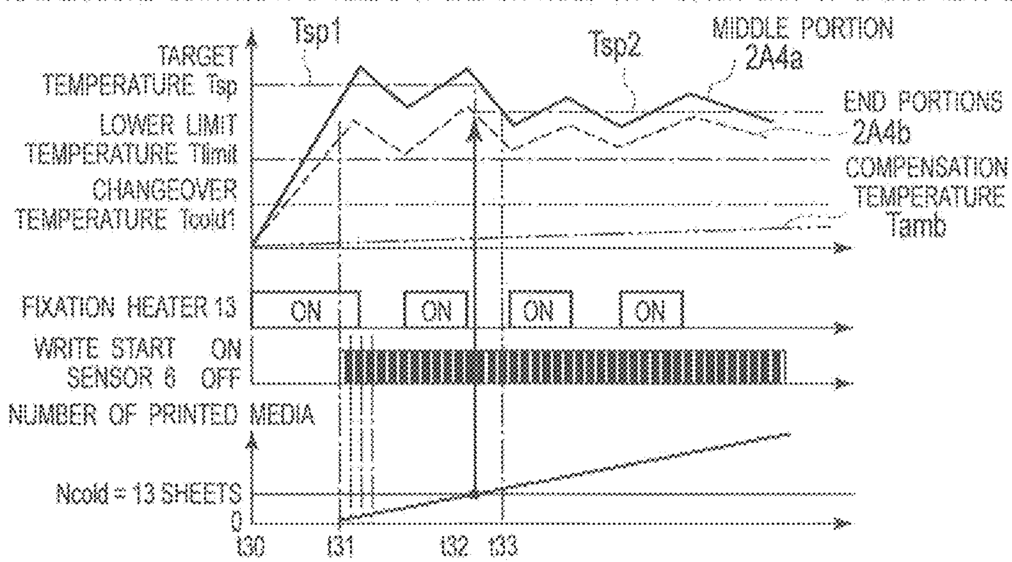
TEMPERATURE CONTROL AND TEMPERATURE CHANGES ON FIXATION UNIT OF EMBODIMENT 2



CASE OF PRINTING ON LETTER-SIZE SHEETS

FIG. 13B

TEMPERATURE CONTROL AND TEMPERATURE CHANGES ON FIXATION UNIT OF EMBODIMENT 2



CASE OF PRINTING ON A4-SIZE SHEETS

FIG. 14

BELT-TYPE FIXATION UNIT

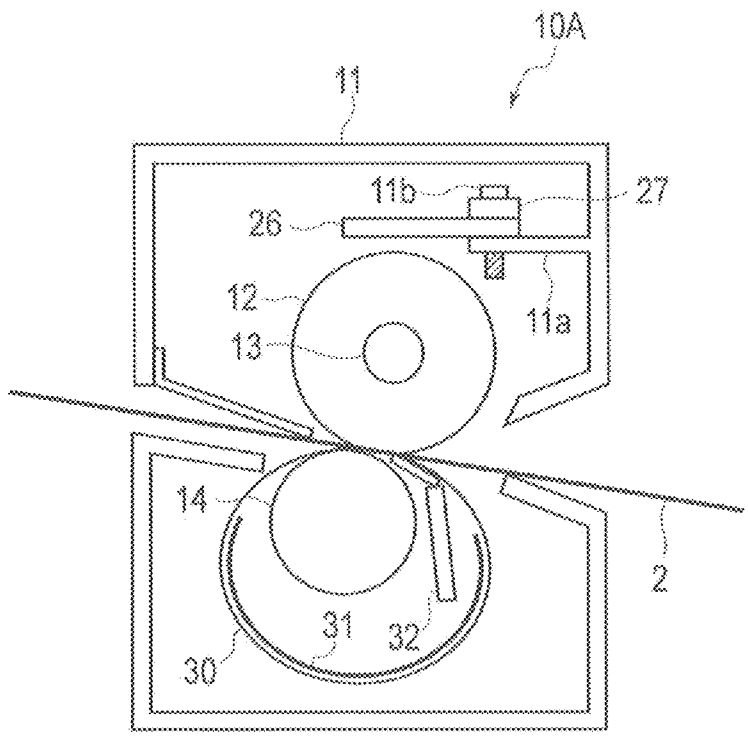


IMAGE FORMATION APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority based on 35 USC 119 from prior Japanese Patent Application No. 2014-089125 filed on Apr. 23, 2014, entitled "IMAGE FORMATION APPARATUS", the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This disclosure relates to an image formation apparatus including a fixation unit.

2. Description of Related Art

An electrophotographic printer as one of image formation apparatuses transfers toner as a developer corresponding to a print image onto a sheet as a print medium, and fixes a toner image as the transferred developer image onto the sheet with heat and pressure of a fixation unit. In a conventional electrophotographic printer described in Japanese Patent Application Publication No. 2008-249763, a fixation unit includes a fixation roller and a pressure roller; and temperature detectors and fixation heaters for heating the fixation roller are disposed at their respective positions which are different from one another in the longitudinal direction. In addition, the fixation heaters are controlled independently of one another based on results of the detection of temperatures by the temperature detectors. This makes it possible to stabilize the temperature of the fixation unit in the longitudinal direction.

SUMMARY OF THE INVENTION

The conventional image formation apparatus, nevertheless, has problems (a) and (b) as follows.

(a) When the image formation apparatus starts printing while the temperature of the fixation unit is low at room temperature, a heat shortage occurs in the end portions of the fixation unit which are close to a support member for supporting the fixation unit because the temperature of the support member is low and the heat capacity of the support member is large. This causes a fixation failure.

(b) A control method of setting the temperature of the fixation unit at a higher temperature in advance is available as the measure to counter the problem (a). However, the image formation apparatus adopting such a control method consumes a larger amount of electric power.

A first aspect of the invention is an image formation apparatus that includes: a heater; a fixation unit supported by a support member, and configured to be heated by the heater and thereby fix an image attached on a print medium onto the print medium; a first temperature detector attached to the support member, and configured to detect a temperature in the vicinity of the fixation unit and output a first detection temperature; a second temperature detector attached to the support member, and configured to detect a temperature of the support member and output a second detection temperature; a medium width detector provided to detect the width of the print medium and output a detected width; and a heat controller configured to change a control condition in accordance with the second detection temperature, a calorific value of the heater and the detected width, and control a temperature of the fixation unit.

A second aspect of the invention is an image formation apparatus that includes: a heater; a fixation unit provided to be heated by the heater and thereby fix an image attached on a print medium onto the print medium; a first temperature detector provided to detect a temperature of the vicinity of the fixation unit and output a first detection temperature; a second temperature detector provided to detect a temperature of a place which is different from that of the first temperature detector, and output a second detection temperature; a medium width detector provided to detect the width of the print medium and output a detected width; and a heat controller configured to control a temperature of the fixation unit based on the first detection temperature and a target temperature. Under a predetermined condition, the heat controller controls the temperature of the fixation unit by setting the target temperature at a first target temperature. If a quantity of heat supplied to the fixation unit exceeds a value for a heat quantity judgment set based on the detected width while controlling the drive of the heater based on the first target temperature and the first detection temperature, the heat controller replaces the first target temperature with a second target temperature which is lower than the first target temperature, and continues fixing the image onto the print medium.

A third aspect of the invention is an image formation apparatus that includes: a heater; a fixation unit provided to be heated by the heater and thereby fix an image attached on a print medium onto the print medium; a first temperature detector provided to detect a temperature of the vicinity of the fixation unit and output a first detection temperature; a second temperature detector provided to detect a temperature of a place which is different from that of the first temperature detector, and output a second detection temperature; a medium width detector provided to detect the width of the print medium and output a detected width; a number-of-printed-print-media detector provided to detect the number of printed print media that have been printed continuously since starting the printing, and output a detected number of printed print media; and a heat controller configured to control a temperature of the fixation unit based on the first detection temperature and a target temperature. Under a predetermined condition, the heat controller controls the temperature of the fixation unit by setting the target temperature at a first target temperature. If the detected number of printed print media exceeds the number of print media for a heat quantity judgment set based on the detected width while controlling the drive of the heater based on the first target temperature and the first detection temperature, the heat controller replaces the first target temperature with a second target temperature which is lower than the first target temperature, and continues fixing the image onto the print medium.

According to the foregoing aspects, the medium width detector detects the width of the print medium, and the heater controller changes the control condition (for instance, the target temperature of the fixation unit) in accordance with the detected width. For this reason, when the image formation apparatus makes the printing on the print medium (for instance, an A4-size sheet) which is narrower than the maximum printable width, the heat controller is capable of giving the fixation unit a minimum necessary heat quantity which does not allow the occurrence of the fixing failure, by changing (lowering, for instance) the target temperature at a time when the quantity of heat inputted into the fixation unit reaches a lower input heat quantity. For this reason, the heat controller is capable of preventing the occurrence of the fixing failure and reducing the power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic configuration block diagram illustrating a control unit in an image formation apparatus illustrated in FIG. **2**.

FIG. **2** is a schematic configuration diagram illustrating the image formation apparatus of Example 1 of the invention.

FIG. **3** is a schematic diagram illustrating a configuration of a roller-type fixation unit and the heat controller illustrated in FIG. **2**.

FIGS. **4**A and **4**B are schematic configuration diagrams illustrating the fixation unit illustrated in FIG. **3**.

FIGS. **5**A to **5**C are diagrams for explaining a schematic configuration of the fixation unit illustrated in FIGS. **4**A and **4**B. FIG. **5**C is a diagram of the distribution of calorific values of the fixation heater illustrated in FIG. **5**A.

FIGS. **6**A and **6**B are schematic diagrams illustrating the configuration of a fixation heater and a heater power supply illustrated in FIG. **5**A.

FIGS. **7**A and **7**B are diagrams for explaining how in a Comparative Example, a print controller performs temperature control on a fixation unit, and how temperatures change.

FIGS. **8**A and **8**B are diagrams for explaining characteristics of the fixation unit illustrated in FIGS. **5**A to **5**C.

FIG. **9** is a flowchart illustrating the processes for temperature control on the fixation unit illustrated in FIG. **1**.

FIGS. **10**A and **10**B are diagrams for explaining how a print controller performs the temperature control once the print controller receives a print request while the fixation unit illustrated in FIGS. **5**A to **5**C is fully cooled, and how temperatures change.

FIGS. **11**A and **11**B are diagrams for explaining characteristics of a fixation unit of Embodiment 2 of the invention.

FIG. **12** is a flowchart illustrating the processes for temperature control on the fixation unit of Embodiment 2 which is illustrated in FIG. **1**.

FIGS. **13**A and **13**B are diagrams for explaining how a print controller performs the temperature control once the print controller receives a print request while the fixation unit of Embodiment 2 illustrated in FIGS. **5**A to **5**C is fully cooled, and how temperatures change.

FIG. **14** is a schematic configuration diagram illustrating a belt-type fixation unit.

DETAILED DESCRIPTION OF EMBODIMENTS

Descriptions are provided hereinbelow for embodiments based on the drawings. In the respective drawings referenced herein, the same constituents are designated by the same reference numerals and duplicate explanation concerning the same constituents is omitted. All of the drawings are provided to illustrate the respective examples only.

[Embodiment 1]

Embodiments for carrying out the invention become apparent from reading the following descriptions for preferred examples while referring to the accompanying drawings. It should be noted that the drawings are provided mainly for the purpose of making the descriptions easy to understand, and do not limit the scope of the invention.

(Configuration of Embodiment 1)

FIG. **2** is a schematic configuration diagram illustrating an image formation apparatus of Embodiment 1 of the invention.

This image formation apparatus is, for instance, an electrophotographic printer, and includes housing **1**. Sheet cassette **3** for containing sheets **2** as print media is detachably installed in a lower portion of housing **1**. Hopping roller **4** for feeding sheets **2** on a one-by-one basis is disposed above a front end of sheet cassette **3**. Sheet **2** fed by hopping roller **4** is transported along sheet transport passage **5** to an upper portion of housing **1**. Sheet transport passage **5** is provided with transport rollers **5***a*, **5***b*, **5***c*, **5***d* for transporting sheet **2** downstream.

Toner image formation unit **7** for forming a toner image as a developer image is disposed downstream of transport roller **5***b* with write start sensor **6** as a number-of-printed-print-media detector interposed in between. Write start sensor **6** is a sensor for detecting where a sheet, before the image formation, is being transported in sheet transport passage **5**. Light emitting diode (hereinafter referred to as an "LED") head **8** as a record light exposure member for emitting a record light is disposed above and adjacent to toner image formation unit **7**. Toner image formation unit **7** forms a toner image on sheet **2** in accordance with the record light emitted from LED head **8**. Toner image formation unit **7** includes, among other things, photosensitive drum **7***a* as an electrostatic latent image carrier, and transfer roller **7***b* as a transfer device for transferring a toner image formed on photosensitive drum **7***a* onto sheet **2**.

Roller-type fixation unit **10**, for instance, is disposed downstream of toner image formation unit **7**. Fixation unit **10** fixes the toner image on sheet **2** to sheet **2** with heat and pressure, and includes support member **11** as a chassis, for instance. Support member **11** supports fixation roller **12** as a fixation device, and pressure roller **14** as a pressure member. Fixation roller **12** houses fixation heater **13** as a heater for heating fixation roller **12** by supplying heat to fixation roller **12**. Transport rollers **5***c*, **5***d* deliver sheet **2**, to which fixation unit **10** fixes the toner image, to stacker **15** outside of housing **1**.

Outside housing **1**, operation panel **18** is provided at a position (on an upper portion of housing **1**, for instance) which enables a user to manipulate operation panel **18**. The user carries out various settings (setting of the thickness and the like of sheets **2**, for instance) with operation panel **18**. As a part of its functions, operation panel **18** includes sheet width setter **18***a* as a medium width detector. By manipulating sheet width setter **18***a*, the user can set the width of sheets **2** which are set in the image formation apparatus. For instance, when letter-size sheets (215.9 mm wide and 279.4 mm long), A4-size sheets (210 mm wide and 297 mm long) and the like are prepared in advance, the user can select one from the letter size, the A4 size and the like using sheet width setter **18***a*. In addition, print controller **20** for controlling the overall print operation and for functioning as a heat controller is provided inside housing **1**.

It should be noted that although the image formation apparatus of Embodiment 1 is designed such that operation panel **18** is provided with sheet width setter **18***a* and the user sets a sheet width using sheet width setter **18***a*, the image formation apparatus may be designed such that: sheet cassette **3** is provided with a sheet size detection mechanism and a sensor; and the sheet size detection mechanism and the sensor automatically detect a sheet size. Otherwise, the image formation apparatus may be designed such that: a print driver is installed in a host apparatus such as a personal computer; and the user selects a sheet width and a sheet size using the print driver.

FIG. **1** is a schematic configuration block diagram illustrating the control unit in the image formation apparatus illustrated in FIG. **2**. The control unit includes print controller **20** which receives instructions from host apparatus **19** such as a personal computer. Following instructions and the like from host apparatus **19**, print controller **20** controls print operations of the image formation apparatus. Print controller **20** includes, among other things, storage **20***a* for storing print temperature Tprn and the like, and heat controller **21** for controlling the heated condition of fixation unit **10**. Print controller **20** comprises a central processing unit (CPU) and/or the like.

Write start sensor **6**, LED head **8**, and operation panel **18** including sheet width setter **18***a* are connected to print controller **20**. Further, connected to print controller **20** are toner image formation unit power supply **22** for applying voltage to toner image formation unit **7**; motor power supply **23** for supplying electric power to sheet transport motor **24** configured to drive transport rollers **5***a* to **5***d* and the like; heater power supply **25** for supplying electric power to fixation heater **13**; non-contact thermistor **26** as a first temperature detector for detecting a temperature of the vicinity of fixation roller **12** and outputting first detection temperature Tnc; and compensation thermistor **27** as a second temperature detector for detecting a temperature of support member **11** to which non-contact thermistor **26** is attached, and outputting compensation temperature Tamb as a second detection temperature.

Heat controller **21** in print controller **20** performs on and off controls on heater power supply **25** by outputting control signal S**21** on the basis of detection temperature Tnc, detected by non-contact thermistor **26**, and compensation temperature Tamb, detected by compensation thermistor **27**, for the purpose of controlling the heating of fixation roller **12** up to a set temperature. Non-contact thermistor **26** and compensation thermistor **27** are unitized as a single temperature detector, and attached to support member **11** for supporting fixation roller and pressure roller **14**. Support member **11** supports non-contact thermistor **26** and fixation roller **12** with a certain clearance between non-contact thermistor **26** and fixation roller **12**. Compensation thermistor **27** performs a function of detecting an amount of heat transfer from non-contact thermistor **26** to support member **11** in the form of a temperature by detecting the temperature of support member **11** to which non-contact thermistor **26** is attached. Heat controller **21** performs a function of detecting the surface temperature of fixation roller **12** without contact from detection temperature Inc from non-contact thermistor **26** and compensation temperature Tamb from compensation thermistor **27**.

FIG. **3** is a schematic diagram illustrating the configuration of roller-type fixation unit **10** and heat controller **21** illustrated in FIG. **2**. FIGS. **4**A and **4**B are schematic configuration diagrams illustrating fixation unit **10** illustrated in FIG. **3**. FIG. **4**A is a perspective view of fixation unit **10**, while FIG. **4**B is a magnified view of a longitudinal section of fixation unit **10** illustrated in FIG. **4**A.

Fixation unit **10** includes: fixation roller **12** for supplying heat to sheet **2** and for transporting sheet **2**; fixation heater **13** for heating fixation roller **12** from inside fixation roller **12**; pressure roller **14** in pressure contact with fixation roller **12**. Fixation heater **13** is disposed inside fixation roller **12** in a way that fixation heater **13** is out of contact or in contact with fixation roller **12**. Among middle portion **12***a* and two end portions **12***b*, **12***c* of fixation roller **12**, two end portions **12***b*, **12***c* are supported by support member **11** using rolling bearings **11***a* as rotatable support members. Similarly, two end portions of pressure roller **14** are supported by support member **11** using rolling bearings **11***b* as rotatable support members. Fixation roller **12** and pressure roller **14** rotate reversely to each other in the arrowed directions in FIG. **3**.

Fixation roller **12** includes a core bar made of an aluminum element tube as a base body with an outer diameter of 30 mm. Fixation roller **12** includes gears which are not illustrated, and is designed such that: transport rollers **5***a* to **5***d* rotationally drive the gears; and the thus-driven gears rotationally drive fixation roller **12**. An elastic body such as a spring (not illustrated), presses pressure roller **14** against fixation roller **12** in a direction in which pressure roller **14** is brought in pressure contact with fixation roller **12**. Pressure roller **14** is in contact with fixation roller **12**, and they form a nip section.

Support member **11** is provided with protrusion **11***c* projecting to the vicinity of the surface of fixation roller **12**. Non-contact thermistor **26** and compensation thermistor **27** are fixed to protrusion **11***c* with screw **11***d*. Non-contact thermistor **26** is disposed at a position which allows non-contact thermistor **26** to detect the temperature of the vicinity of the surface of fixation roller **12** (for instance, the vicinity of middle portion **12***a*) without contact. Compensation thermistor **27** is disposed at a position which allows compensation thermistor **27** to detect the temperature of protrusion **11***c*. Non-contact thermistor **26** and compensation thermistor **27** are thermosensitive devices which change their resistance values in accordance with the temperature. Heat controller **21** detects the resistance values of non-contact thermistor **26** and compensation thermistor **27**, and thereby detects the temperatures of non-contact thermistor **26** and compensation thermistor **27**. Non-contact thermistor **26** and compensation thermistor **27** of Embodiment 1 use negative characteristic thermistors which decreases their resistance values in accordance with an increase in the temperature, for instance.

On the basis of detection temperature Tnc from non-contact thermistor **26** and compensation temperature Tamb from compensation thermistor **27**, heat controller **21** detects surface temperature Tc of fixation roller **12** without contact. This detection method is expressed with

$$Tc=\alpha\times(Tnc-Tamb)+Tamb$$

where α denotes an experimentally-obtained coefficient (1.2, for instance).

For instance, if Tnc=150° C. and Tamb=30° C., surface temperature Tc of fixation roller **12** is obtained as follows:

$$Tc=1.2\times(150-30)+30=174°\text{ C.}$$

FIGS. **5**A to **5**C are diagrams for explaining a schematic configuration of fixation unit **10** illustrated in FIGS. **4**A and **4**B. FIG. **5**A is a magnified longitudinal cross-sectional view of fixation unit **10** illustrated in FIG. **4**A. FIG. **5**B is a schematic side view of fixation unit **10** illustrated in FIG. **5**A. FIG. **5**C is a diagram of the distribution of calorific values of fixation heater **13** illustrated in FIG. **5**A. In FIG. **5**C, the horizontal axis indicates longitudinal positions along fixation heater **13** (namely, positions of middle portion **13***a* and two end portions **13***b*, **13***c*, respectively), and the vertical axis indicates the calorific value of the heater.

As illustrated in FIGS. **5**A and **5**B, single fixation heater **13** is disposed inside fixation roller **12**. As illustrated in FIG. **5**C, the longitudinal distribution of calorific values of fixation heater **13** is designed such that two end portions **13***b*, **13***c* generate more heat than middle portion **13***a*.

FIGS. **6**A and **6**B are schematic diagrams illustrating the configuration of fixation heater **13** and heater power supply **25** illustrated in FIG. **5**A. FIG. **6**A is the configuration diagram of fixation heater **13** and heater power supply **25**, and FIG. **6**B is the diagram illustrating ON and OFF states of fixation heater **13** illustrated in FIG. **6**A. In FIG. **6**B, the horizontal axis indicates time, and the vertical axis indicates calorific values in the ON and OFF states of fixation heater **13**.

As illustrated in FIG. **6**A, fixation heater **13** is, for instance, a halogen lamp, and includes filament **13***d* as a heat generation element. Filament **13***d* is enclosed in glass tube **13***e*. Support member **11** supports filament **13***d* inside fixation roller **12**. The two end portions of glass tube **13***e* are provided with insulators **13***f*, respectively. Insulators **13***f* electrically insulate filament **13***d* from support member **11**. In insulators **13***f*, the two ends of filament **13***d* are connected to heater wiring **28** for electric power transmission. Filament **13***d* is connected to AC heater power supply **25** with heater wiring **28** via switch for controlling the electric power supply. Switch **29** performs on and off operations depending on control signal S**21** outputted from heat controller **21**, and thereby controls the supply and cutoff of the electric power from heater power supply **25** to fixation heater **13**.

In this respect, a tungsten filament or the like is used for filament **13***d*, for instance. Filament **13***d*, together with an inert gas such as argon or krypton, bromine, chlorine or the like in the form of a halogenated organic compound, is enclosed in glass tube **13***e*. When heated and cooled, a halogen cycle is created between the tungsten and a halogen produced from the halogenated organic compound. Thereby, fixation unit **10** is capable of offering the heating function over its lifespan. Insulation members such as ceramic members are used for insulators **13***f*, for instance. Furthermore, a semiconductor switch such as a triac capable of transmitting a large current is used for switch **29**.

In the circuit illustrated in FIG. **6**A, when switch **29** is in an ON state, AC power (with an AC voltage of 100 V, for instance) supplied from heater power supply **25** is sent to filament **13***d* via heater wiring **28**, and filament **13***d* generates heat (with an output power of 1200 W, for instance) using the power. Glass tube **13***e* is transparent. Glass tube **13***e* is designed to transmit heat generated by the heat generation of filament **13***d*, and to send the heat to an inner surface of the core bar of fixation roller **12**.

FIG. **6**B illustrates a relationship between the ON and OFF states of switch **29** and the calorific value of fixation heater **13**. Switch **29** can create only the two states, namely corresponding to the supply and cutoff of the AC power from heater power supply **25**. For this reason, the controlling of the amount of heat applied to fixation roller **12** is achieved by controlling the length of heating time within a predetermined period of time.

FIG. **5**C illustrates the distribution of the calorific values of fixation heater **13** illustrated in FIG. **6**A, which is installed in fixation unit **10** illustrated in FIG. **5**A.

As illustrated in FIG. **5**C, the longitudinal distribution of the calorific values of fixation heater **13** is designed such that two end portions **13***b*, **13***c* generate more heat than middle portion **13***a*. The reason for this is as follows.

Fixation roller **12** is designed to be rotatable since fixation roller **12** needs to transport sheet **2** while sheet **2** is interposed between fixation roller **12** and pressure roller **14**. Support member **11** supports the two end portions **12***b*, **12***c* of fixation roller **12** with rotatable rolling bearings **11***a* interposed in between. For this reason, part of the heat transmitted to fixation roller **12** by the heat generation of fixation heater **13** is transferred to support member **11** via rolling bearings **11***a*. Because support member **11** needs strength, support member **11** needs to be large and solid. As a result, support member **11** needs a larger quantity of heat for the purpose of raising its own temperature, and the quantity of heat needed by support member **11** for the purpose is extremely greater than that needed by fixation roller **12**. In other words, the heat capacity of support member **11** is extremely greater than that of fixation roller **12**.

Accordingly, particularly when the heating of fixation roller **12** is started from a state where the entirety of fixation unit **10** is cooled down to room temperature, the temperature of middle portion **12***a* of fixation roller **12** rises, but the temperatures of two longitudinal end portions **12***b*, **12***c* of fixation roller **12** do not rise enough higher than room temperature since part of the heat of two longitudinal end portions **12***b*, **12***c* of fixation roller **12** is transferred (radiated) to support member **11**. For this reason, there is the likelihood that a fixation failure occurs. For the purpose of preventing the fixation failure at the time of print start, Embodiment 1 sets the higher calorific value for two end portions **13***b*, **13***c* of fixation heater **13**.

(Working of Embodiment 1)

For the purpose of clarifying how Embodiment 1 works, descriptions are provided for (I) how the image formation apparatus works as a whole, (II) how Comparative Example works for fixation control, and (III) how Embodiment 1 works for fixation control.

(I) Working of Embodiment 1 as a Whole

Referring to FIGS. **1** and **2**, for instance once print controller **20** receives a print instruction from host apparatus **19**, print controller **20** drives LED head **8**, toner image formation unit power supply **22**, and motor power supply **23** by outputting a control signal. Furthermore, print controller **20** turns switch **29** (illustrated in FIG. **6**) on by outputting control signal S**21**, and thereby makes heater power supply **25** output AC power.

Once motor power supply **23** is driven, sheet transport motor **24** rotates, and hopping roller **4** and transport rollers **5***a* to **5***d* on sheet transport passage **5** operate. The operation of hopping roller **4** feeds sheet **2** from inside sheet cassette **3** to sheet transport passage **5**. Transport rollers **5***a*, **5***b* transport thus-fed sheet **2** to write start sensor **6** located downstream of transport rollers **5***a*, **5***b*. Thereafter, on the basis of the detection by write start sensor **6**, sheet **2** is transported to toner image formation unit **7** by being timed to coincide with the image formation.

Depending on the print information such as sheet width information from sheet width setter **18***a*, LED head **8** emits record light onto photosensitive drum **7***a* inside toner image formation unit **7**. Thereby, depending on the thus-emitted record right, transfer roller **7***b* inside toner image formation unit **7** transfers a toner image onto sheet **2**. Sheet **2**, onto which the toner image is transferred, is transported to fixation unit **10**, where fixation roller **12** and pressure roller **14** fix the toner image to sheet **2** with heat and pressure. Transport rollers **5***c*, **5***d* deliver sheet **2** to which the toner image is fixed to stacker **15** outside housing **1**. The operation for the image formation ends with this.

(II) Working of Comparative Example for Fixation Control

FIGS. **7**A and **7**B are diagrams for explaining how a Comparative Example controls temperatures of a fixation unit, and how the temperatures change. FIG. **7**A is the diagram illustrating how the temperatures change while under the control of the Comparative Example, with the printing being made on letter-size sheets **2**LT whose width is a maximum printable width. FIG. **7**B is the diagram illustrating how the temperatures change while under the control of the Comparative Example, with the printing being made on A4-size sheets **2A4** whose width is narrower than that of letter-size sheets **2**LT.

FIGS. 7A and 7B each illustrate how the temperature of each part of the fixation unit of the Comparative Example changes with time while the temperature is rising (warming up) from room temperature, and while the temperature is controlled on the basis of predetermined temperatures. In FIGS. 7A and 7B, the horizontal axis indicates time, and the vertical axis indicates temperatures (target temperature Tsp, lower limit temperature Tlimit, and changeover temperature Tcold**1**).

As illustrated in FIG. **7**A, when the printing is made on letter-size sheet **2**LT whose width is a maximum printable width, the temperatures of middle portion **2**LTa and each end portion **2**LTb of sheet **2**LT are controlled in a way that the temperature of each end portions **2**LTb becomes equal to a temperature which is not less than lower limit temperature Tlimit, but is the lowest above lower limit temperature Tlimit; and power consumption is minimized within a range where no printing failure occurs.

In contrast to this, as illustrated in FIG. **7**B, when the same control as illustrated in FIG. **7**A is performed on the printing to be made on A4-size sheet **2**A**4** whose width is narrower, the temperatures of middle portion **2**A**4***a* and each end portion **2**A**4***b* of sheet **2**A**4** are controlled in a way that the temperature of each end portion **2**A**4***b* becomes equal to a temperature which is unnecessarily higher than lower limit temperature Tlimit; and although no printing failure occurs, there is room for improvement in power consumption because the power consumption is not sufficiently low.

The reason for the difference between the case illustrated in FIG. **7**A and the case illustrated in FIG. **7**B is that although the width of the heat generation element in fixation heater **13** remains unchanged between the two cases, the width of the sheet from which heat is dissipated is different between sheet **2**LT and sheet **2**A**4**, and the quantity of heat dissipated from fixation roller **12** is smaller at end portions **2**A**4***b* of sheet **2**A**4** than at end portions **2**LTb of sheet **2**LT because the width of sheet **2**A**4** is narrower than that of sheet **2**LT. As a result, even though the input heat quantity from fixation heater **13** as a whole is the same between the two cases, the quantity of heat remaining at end portions **12***b*, **12***c* of fixation roller **12** is larger in the case of the narrower sheet width, and the temperatures of the end portions are accordingly higher in the case of the narrower sheet width. In other words, when the temperatures of the end portions are raised to the same level, the narrower sheet width requires a smaller input heat quantity.

The following descriptions are provided for how the fixation control employed in Embodiment 1 works in order to solve the problem with a Comparative Example like this.

(III) Working of Embodiment 1 for Fixation Control

FIGS. **8**A and **8**B are diagrams for explaining characteristics of fixation unit **10** illustrated in FIGS. **5**A to **5**C. FIG. **8**A is the diagram illustrating a relationship which is observed during printing between the input heat quantity [kJ] (indicated by the horizontal axis) and the temperature difference [° C.] (indicated by the vertical axis) between middle portion **12***a* and end portions **12***b*, **12***c* of fixation roller **12** for each of sheet widths (the letter-size width, the A4-size width, the B5-size width and the A5-size width). As for the sheet width, the letter size measures 215.9 mm wide×279.4 mm long; the A4 size measures 210 mm wider 297 mm long; the B5 size measures 182 mm wide×257 mm long; and the A5 size measures 148 mm wide×210 mm long.

In addition, FIG. **8**B is a graph which, for each sheet width [mm], illustrates an input heat quantity [kJ] needed to satisfy a condition where the temperature difference [° C.] in FIG. **8**A is minus 15 [° C.]. That is, FIG. **8**B illustrates a relationship between each sheet width [mm] (indicated by the horizontal axis) and the corresponding input heat quantity [kJ] (indicated by the vertical axis).

As illustrated in FIG. **8**A, it is learned that as the sheet width becomes wider, the input heat quantity needed to bring the temperatures of the end portions closer to the temperature of the middle portion becomes larger. Furthermore, as illustrated FIG. **8**B, it is learned that even though the sheet width difference between each of the two sizes close to each other, such as between the letter size and the A4 size, is small, the change in the needed input heat quantity is large between the two sizes.

The reason for this is that: although the width of the heat generation element in fixation heater **13** remains unchanged among the four sizes, the width of the sheet from which heat is dissipated is different from one another; and as the width of sheet **2** becomes narrower, the quantity of heat dissipated from fixation roller **12** in the sheet end portions becomes smaller. As a result, even though the equal input heat quantity is inputted from fixation heater **13**, the narrower sheet width makes the temperatures of the end portions become higher since the quantity of heat remaining at end portions **12***b*, **12***c* of fixation roller **12** becomes larger. In other words, as the sheet width becomes narrower, the input heat quantity needed to raise the temperatures of the end portions to the same level becomes smaller.

Based on the relationship between the sheet width and the temperature difference between the middle portion and the end portions for each sheet size as illustrated in FIG. **8**B, Embodiment 1 uses the quantity of heat supplied to fixation roller **12** (namely, the input heat quantity), which makes particularly the temperature difference between the middle portion and the end portions become necessarily and sufficiently small, as a value for the input heat quantity judgment. In other words, for each of the sheet widths of the sheets on which printing is made, if the input heat quantity is less than the corresponding value in FIG. **8**B, the quantity of heat inputted into end portions **12***b*, **12***c* of fixation roller **12** can be judged as insufficient and the temperatures of the sheet end portions also can be judged as insufficient. Embodiment 1 performs the control by employing the foregoing characteristics.

Embodiment 1 performs the fixation control as follows. Once print controller **20** receives the print instruction, print controller **20** makes sheet transport motor **24** rotate fixation roller **12** via gears (not illustrated). Subsequently, heat controller **21** judges whether or not the temperature of fixation roller **12**, obtained by correcting detection temperature Tnc of fixation unit **10** detected by non-contact thermistor **26** using compensation temperature Tamb detected by compensation thermistor **27**, falls within a predetermined printable temperature range. If the temperature of fixation roller **12** falls within the range, print controller **20** starts to transport sheet **2**.

The printable temperature range is a temperature range which enables toner to be normally fixed to sheet **2**, and which has a lower limit temperature Tlimit (160° C., for instance) and an upper limit temperature T**2** (200° C., for instance). If the temperature is higher than upper limit temperature T**2**, heat controller **21** turns off switch **29** (illustrated in FIG. **6**A) using control signal S**21**, stops the supply of the power to fixation heater **13** from heater power supply **25**, and thereby decreases (or cools down) the temperature of fixation roller **12**. In contrast to this, if the temperature is lower than lower limit temperature Tlimit, heat controller **21** turns on switch **29** (illustrated in FIG. **6**A) using control signal S**21**, supplies the power to fixation heater **13** from heater power supply **25**, and thereby increases (warms up) the temperature of fixation roller **12**.

FIG. **9** is a flowchart illustrating the processes for temperature control on fixation unit **10** illustrated in FIG. **1**. Once print controller **20** starts to perform the temperature control on fixation unit **10**, the process flow proceeds to step ST**1**. In step ST**1**, print controller **20** detects whether or not a print request occurs from host apparatus **19**. If no print request occurs (if N), print controller **20** waits for a print request to occur. If a print request occurs (if Y), the process flow proceeds to step ST**2**.

In step ST**2**, heat controller **21** detects the temperature of protrusion **11***c* of support member **11** from compensation temperature Tamb detected by compensation thermistor **27**. In addition, print controller **20** sends the contents of the print request from host apparatus **19** to heat controller **21**. Heat controller **21** sets print temperature Tprn which heat controller **21** judges as optimal from information on the received contents of the print request. For the purpose of making the temperature of fixation roller **12** becomes equal to print temperature Tprn, heat controller **21** supplies and cuts off the power from heater power supply **25** by turning on and off switch **29** (illustrated in FIG. **6**A) using control signal S**21**, and thereby controls the drive of fixation heater **13**. Print temperature Tprn is a temperature set optimal for each print condition. Print temperature Tprn is experimentally obtained, and is stored in storage **20***a* in print controller **20** in advance. Thereafter, the process flow proceeds to step ST**3**.

In step ST**3**, print controller **20** detects the print sheet width set with sheet width setter **18***a*, and sets the value for input heat quantity judgment Jhot**1**, as an optimal value for heat quantity judgment, from information on the detection. The value for input heat quantity judgment Jhot**1** can be obtained by being selected from the relationships illustrated in FIG. **11**B which are experimentally obtained with the foregoing method in advance (namely, the relationships between the sheet widths and values for input heat quantity judgment Jhot**1**. For instance, Jhot**1**=18 kJ for printing to be made on letter-size sheet **2**LT, and Jhot**1**=14 kJ for printing to be made on A4-size sheet **2**A4. Thereafter, the process flow proceeds to step ST**4**.

In step ST**4**, heat controller **21** compares compensation temperature Tamb with changeover temperature Tcold**1** which is set as the reference in advance. If Tamb≥Tcold**1**, or if compensation temperature Tamb is not less than changeover temperature Tcold**1** (if N), heat controller **21** judges that fixation unit **10** warms up to a necessary and sufficient extent, and the process flow proceeds to step ST**6** without correcting target temperature Tsp (target temperature Tsp=print temperature Tprn). If Tamb<Tcold**1**, or if compensation temperature Tamb is less than changeover temperature Tcold**1** (if Y), heat controller **21** judges that the temperature of fixation unit **10** is lower. Thereafter, the process flow proceeds to step ST**5**.

In step ST**5**, heat controller **21** corrects target temperature Tsp (in a way that target temperature Tsp=print temperature Tprn+correction temperature ΔT) since the temperature of fixation unit **10** is lower. Thereafter, the process flow proceeds to step ST**6**. In this respect, for instance, target temperature Tsp=200° C. when print temperature Tprn=180° C. and correction temperature ΔT=20° C.

As compensation temperature Tamb becomes lower, heat controller **21** judges that the temperature of fixation unit **10** cools to a lower temperature, and thereby corrects target temperature Tsp so as to make target temperature Tsp become higher. The reason for this is that lower compensation temperature Tamb enables heat controller **21** to judge that the temperatures of rolling bearings **11***a* supporting fixation roller **12** are lower. As the temperatures of rolling bearings **11***a* become lower, the quantity of heat dissipated from end portions **12***b*, **12***c* of fixation roller **12** which are in contact with, and supported by, rolling bearings **11***a* becomes larger, leading to a phenomenon that the temperatures of the end portions of fixation roller **12** become lower. For the purpose of compensating for the decrease in the temperature of fixation roller **12**, heat controller **21** sets target temperature Tsp higher.

In step ST**6**, once print controller **20** judges that the temperature of fixation unit **10** falls within a print start enabling temperature range, print controller **20** starts printing. Thereafter, the process flow proceeds to step ST**7**. In step ST**7**, heat controller **21** makes heater power supply **25** supply the AC power to fixation heater **13** by turning on switch **29** (illustrated in FIG. **6**) using control signal S**21**, and thereby turns on fixation heater **13** (Y). Thereafter, the process flow proceeds to step ST**8**. If heat controller **21** does not turn on fixation heater **13** (if N), the process flow proceeds to step ST**9**.

In step ST**8**, heat controller **21** calculates the input heat quantity (by multiplying the power in watts by the ON-time length in seconds) from the ON state of fixation heater **13**. Thereafter, the process flow proceeds to step ST**9**. The input heat quantity is, for instance, a quantity in joules which are units of energy. One may consider that, for instance, the following method is suitable as a method of calculating the input heat quantity. As described above, heat controller **21** controls fixation heater **13** in a way that the calorific value of fixation heater **13** is either 100% or 0%. For this reason, if for instance, the 100% of the calorific value is 1200 W, the input heat quantity [kJ] can be obtained by multiplying the calorific value [in watts] by the time length [in seconds] for which fixation heater **13** is in the ON state.

In step ST**9**, heat controller **21** compares the calculated input heat quantity up to now with the value for input heat quantity judgment Jhot**1**. If input heat quantity≥Jhot**1**, or if the input heat quantity is not less than the value for input heat quantity judgment Jhot**1** (if Y), the process flow proceeds to step ST**11**. In step ST**11**, heat controller **21** judges that end portions **12***b*, **12***c* of fixation roller **12** sufficiently warm up as a result of inputting a necessary and sufficient heat quantity into fixation unit **10**, and cancels the correction to target temperature Tsp (target temperature Tsp=print temperature Tprn). Thereafter, the process flow proceeds to step ST**12**.

In step ST**9**, if the input heat quantity<Jhot**1**, or if the input heat quantity is less than the value for input heat quantity judgment Jhot1 (if N), heat controller **21** judges that the temperatures of end portions **12***b*, **12***c* of fixation roller **12** are lower as a result of inputting an insufficient input heat quantity into fixation unit **10**, and continues correcting target temperature Tsp. Thereafter, the process flow proceeds to step ST**10**. In step ST**10**, heat controller **21** compares compensation temperature Tamb and changeover temperature Tcold**1**, like in step ST**4**. If heat controller **21** judges that fixation unit **10** sufficiently warms up (if N), the process flow proceeds to step S**11**. In step S**11**, heat controller **21** cancels the correction to target temperature Tsp (target temperature Tsp=print temperature Tprn). Thereafter, the process flow proceeds to step S**12**. In step S**10**, if heat controller **21** judges

that fixation unit **10** remains yet to warm up (if Y), then heat controller **21** continues correcting target temperature Tsp. Thereafter, the process flow proceeds to step ST**12**.

In step ST**12**, print controller **20** detects whether or not the printing comes to an end. If the printing does not come to an end (if N), the process flow repeats steps ST**7** through ST**12**. If the printing comes to an end (if Y), print controller **20** terminates the temperature control.

FIGS. **10**A and **10**B are diagrams each illustrating how print controller **20** performs the temperature control once print controller **20** receives a print request while fixation unit **10**, illustrated in FIGS. **5**A to **5**C, fully cools down, and how temperatures change. FIG. **10**A is the diagram for the printing on letter-size sheets **2**LT, and FIG. **10**B is the diagram for the printing on A4-size sheets **2A4**.

The upper half of each of FIGS. **10**A and **10**B is a graph illustrating how the temperatures of the respective parts change with time. The horizontal axis in the upper half of FIG. **10**A indicates times t**0** to t**3**, . . . , while the horizontal axis in the upper half of FIG. **10**B indicates times t**10** to t**13**, ... The vertical axis in the upper half of each of FIGS. **10**A and **10**B indicates temperatures (first target temperature Tsp**1** which is a higher target temperature Tsp, second target temperature Tsp**2** which is a lower target temperature Tsp, lower limit temperature Tlimit, and changeover temperature Tcold**1**). The lower half of each of FIGS. **10**A and **10**B is a graph illustrating ON states of fixation heater **13**, and a result of calculating a quantity of heat inputted into fixation roller **12**. The horizontal axis in the lower half of FIG. **10**A indicates times t**0** to t**3**, . . . , while the horizontal axis in the lower half of FIG. **10**B indicates times t**10** to t**13**, ... The vertical axis in the lower half of each of FIGS. **10**A and **10**B indicates the ON states of fixation heater **13**, the input heat quantity, and the value for input heat quantity judgment Jhot**1**.

Under a condition of room temperature, the temperatures of the parts of fixation unit **10** at times t**1**, t**10** in FIGS. **10**A and **10**B are equal to one another. Once print controller **20** receives the print request while in this state, print controller **20** makes heat controller **21** start to perform the heat control on fixation roller **12**, and to heat fixation roller **12**. Heat controller **21** detects that compensation temperature Tamb is lower than changeover temperature Tcold**1**, and sets target temperature Tsp at first target temperature Tsp**1** as the correction to target temperature Tsp. As a result, heat controller **21** controls the heating of fixation roller **12** in a way that the temperature of fixation roller **12** becomes higher than print temperature Tprn.

Once the temperature rise reaches the print start enabling temperature range at each of times t**1**, t**11**, print controller **20** starts the processes for the printing. Heat controller **21** always continues controlling the heater drive. Thereby, heat controller **21** controls the temperatures of sheet middle portions **2**LTa, **2A4***a* in a way that the temperatures thereof become equal to first target temperature Tsp**1**.

Heat controller **21** always continues calculating the input heat quantity as well. As a result, at each of times t**2**, t**12**, if heat controller **21** judges that the input heat quantity exceeds the value for input heat quantity judgment Jhot**1**, heat controller **21** switches the correction to target temperature Tsp to the setting of target temperature Tsp at second target temperature Tsp**2** in exchange for cancelling the setting of target temperature Tsp at first target temperature Tsp**1**. Thereby, heat controller **21** controls the temperature of fixation roller **12** in a way that the temperature thereof becomes equal to print temperature Tprn. At this time, since the input heat quantity is sufficient, the temperature difference between sheet middle portion **2**LTa and sheet end portions **2**LTb, as well as the temperature difference between sheet middle portion **2A4***a* and sheet end portions **2A4***b*, becomes sufficiently small. For this reason, after heat controller **21** switches the correction to target temperature Tsp to the setting of target temperature Tsp at second target temperature Tsp**2** in exchange for cancelling the setting of target temperature Tsp at first target temperature Tsp**1**, the temperatures of the end portions do not become lower than lower limit temperature Tlimit, either. Thus, no fixation failure occurs at each of times t**3**, t**13**.

It should be noted that the comparison between the cases illustrated in FIGS. **10**A and **10**B shows that the length of time up until the cancelling of the setting of target temperature Tsp at first target temperature Tsp**1** is shorter in the case illustrated in FIG. **10**B, namely in the case of the narrower sheet width. The reason for this is that the narrower sheet width makes the value for input heat quantity judgment Jhot**1** (=10) become smaller. As a result, because the length of time for which target temperature Tsp is kept set at the higher value (namely, the length of time for which target temperature Tsp is kept set at first target temperature Tsp**1**) can be made shorter, the image formation apparatus is capable of making the printing with less electric power.

(Effect of Embodiment 1)

According to Embodiment 1, heat controller **21** corrects target temperature Tsp with an optimal input heat quantity depending on the sheet width. For this reason, even in the case of the narrower sheet width, the image formation apparatus is capable of making the printing with a minimum of necessary power consumption, and is accordingly capable of preventing a useless increase in power consumption.

[Embodiment 2]

(Configuration of Embodiment 2)

An image formation apparatus of Embodiment 2 of the invention has the same configuration as that of Embodiment 1, but is different from that of Embodiment 1 in terms of the method by which heat controller **21** controls the heating of fixation roller **12**.

(Working of Embodiment 2)

Unlike the way heat controller **21** of Embodiment 1 calculates the input heat quantity, heat controller **21** of Embodiment 2 counts the number of printed print media, and judges that the input heat quantity is smaller when the counted number of printed print media is less than the number of print media for input heat quantity judgment Ncold as a predetermined number of print media for the heat quantity judgment.

FIGS. **11**A and **11**B are diagrams for explaining characteristics of fixation unit **10** of Embodiment 2 of the invention (namely, characteristics representing a relationship of each sheet width with the corresponding number of printed print media needed for the temperature difference between the sheet middle portion and end portions to become equal to minus 15° C.). FIG. **11**A is the diagram which, for each sheet width, illustrates the relationship of the number of printed print media (indicated by the horizontal axis) with the temperature difference between the middle portion and end portions of each sheet **2** on which printing is made (indicated by the vertical axis). For each sheet width, FIG. **11**B graphs the number of printed print media needed for the temperature difference illustrated in FIG. **11**A to become equal to minus 15° C. FIG. **11**B is the diagram illustrating the relationship of each sheet width (indicated by the horizontal axis) and the corresponding number of printed print media (indicated by the vertical axis)

When one sheet is made to pass through fixation unit **10** illustrated in FIGS. **3**, **4**A and **4**B, sheet **2** with a lower temperature comes into contact with fixation roller **12** in the nip section, which is the section where fixation roller **12** and pressure roller **14** are in contact with each other. Thereby, heat is transferred from fixation roller **12** with a higher temperature to sheet **2** with the lower temperature, and the temperature of fixation roller **12** accordingly becomes lower. Heat controller **21** illustrated in FIG. **3** heats fixation roller **12** with a necessary quantity of heat for the purpose of compensating for the temperature drop which occurs due to the contact of sheet **2** with the nip section.

Thus, as the number of printed print media, which is the number of print media made to pass through fixation unit **10**, becomes larger, the quantity of heat transferred from fixation roller **12** to sheets **2** becomes larger, and heat controller **21** heats fixation roller **12** with more quantity of heat. In other words, since the number of printed print media is proportional to the input heat quantity, heat controller **21** is capable of judging whether or not the necessary and sufficient input heat quantity is given to fixation roller **12** from the number of printed print media. If the number of printed print media is not less than the number of print media for input heat quantity judgment, heat controller **21** is capable of judging that the end portions are kept at the necessary and sufficient temperature. Accordingly, no offset occurs even if target temperature Tsp is decreased to second target temperature Tsp**2**.

In addition, in a case where the image formation apparatus continues making printing by changing the sheet width to a narrower one, heat controller **21** is capable of raising the temperatures of the sheet end portions to the necessary and sufficient temperature in the course of making the printing on a smaller number of print media since the quantity of heat remaining in end portions **12***b*, **12***c* of fixation roller **12** becomes larger.

For instance, while the image formation apparatus is making printing on letter-size sheets **2**LT, the relationship illustrated in FIG. **11**B makes it possible to judge that a sufficient input heat quantity is given to end portions **12***b*, **12***c* of fixation roller **12** when the number of printed print media exceeds 21. Similarly, while the sheet width is the A4 width, the relationship illustrated in FIG. **11**B makes it possible to judge that a sufficient input heat quantity is given to end portions **12***b*, **12***c* of fixation roller **12** when the number of printed print media exceeds 13. Employing the characteristics like these, Embodiment 2 controls the fixation temperature.

FIG. **12** is a flowchart illustrating the processes for temperature control on fixation unit **10** of Embodiment 2 which is illustrated in FIG. **1**. Components which are the same as those in FIG. **9** illustrating the flowchart of Embodiment 1 are denoted by the same reference signs.

The processes in steps ST**3**A, ST**7**A to ST**9**A, and ST**13**A in the flowchart of Embodiment 2 are different from the processes in steps ST**3**, ST**7** to ST**9**, and ST**13** in the flowchart of Embodiment 1.

Once print controller **20** illustrated in FIG. **1** starts to perform the temperature control on fixation unit **10**, print controller **20** performs the processes in steps ST**1**, ST**2** which are the same as those in Embodiment 1. Thereafter, the process flow proceeds to step ST**3**A.

In step ST**3**A, print controller **20** illustrated in FIG. **1** sets the number of print media for input heat quantity judgment Ncold, which is an optimal number of print media for the judgment, from information on a sheet width which the user sets using sheet width setter **18***a* as a medium width detector. Print controller **20** is capable of obtaining the number of print media for input heat quantity judgment Ncold by selecting it from the relationships illustrated in FIG. **11**B which are experimentally obtained in advance using the foregoing method of Embodiment 1 (the relationships between the sheet widths and numbers of sheets for input heat quantity judgment Ncold). Subsequently, print controller **20** performs the processes of steps ST**4** to ST**6** which are the same as those in Embodiment 1. Thereafter, the process flow proceeds to step ST**7**A.

In step ST**7**A, once print controller **20** starts printing, print controller **20** detects the state of write start sensor **6** as the number-of-printed-print-media detector, and thereby detects a change of the state of write start sensor **6** from the OFF state to the ON state. This change is that from the absence to the presence of sheet **2**. By detecting this change, print controller **20** is capable of detecting the number of printed print media. Thereafter, the process flow proceeds to step ST**8**A.

In step ST**8**A, print controller **20** adds 1 (one) to the current number of printed print media. Thereafter, the process flow proceeds to step ST**9**A. In step ST**9**A, print controller **20** compares the number of printed print media, which write start sensor **6** counts, with the number of print media for input heat quantity judgment Ncold beforehand determined and stored. If the number of printed print media is less than the number of print media for input heat quantity judgment Ncold (if Y), print controller **20** performs the process of step ST**10** which is the same as that in Embodiment 1.

In step ST**9**A, if the number of printed print media is not less than the number of print media for input heat quantity judgment Ncold (if N), print controller **20** performs the process of step ST**11** which is the same as that in Embodiment 1. The number of print media for input heat quantity judgment Ncold is that which is experimentally obtained in advance, and the number of print media which enables the sheet end portions to obtain the necessary and sufficient temperatures can be obtained experimentally. For instance, the number of print media for input heat quantity judgment Ncold is 21 for the printing on letter-size sheets **2**LT, while the number of print media for input heat quantity judgment Ncold is 13 for the printing on A4-size sheets **2**A4. Subsequently, print controller **20** performs the process of step ST**12** which is the same as that in Embodiment 1. Thereafter, the process flow proceeds to step ST**13**A. In step ST**13**A, print controller **20** clears the added-up number of printed print media after the processes for the printing come to an end.

The repetition of the foregoing processes makes it possible to prevent the offset more easily, and to save the energy.

FIGS. **13**A and **13**B are diagrams each illustrating how print controller **20** performs the temperature control once print controller **20** receives a print request while fixation unit **10** illustrated in FIGS. **5**A to **5**C fully cools down, and how temperatures change. FIG. **13**A is the diagram for the printing on letter-size sheets **2**LT, and FIG. **13**B is the diagram for the printing on A4-size sheets **2**A4.

The upper third of each of FIGS. **13**A and **13**B is a graph illustrating how the temperatures of the respective parts change with time. The horizontal axis in the upper third of FIG. **13**A indicates times t**20** to t**23**, . . . , while the horizontal axis in the upper third of FIG. **13**B indicates times t**30** to t**33**, ... The vertical axis in the upper third of each of FIGS. **13**A and **13**B indicates temperatures (first target temperature Tsp**1** which is the higher target temperature Tsp, second target temperature Tsp**2** which is the lower target temperature Tsp, lower limit temperature Tlimit, and changeover temperature Tcold**1**). The lower third of each of FIGS. **13**A and **13**B illustrates ON states of fixation heater **13** and ON states of write start sensor **6**. Furthermore, the lowermost third of each of FIGS. **13**A and **13**B is a graph illustrating how many sheets are printed. The horizontal axis in the lowermost third of FIG. **13**A indicates times t**20** to t**23**, . . . , while the horizontal axis in the lowermost third of FIG. **13**B indicates times t**30** to t**33**, ... The vertical axis in the lowermost third of each of FIGS. **13**A and **13**B indicates the number of print media for input heat quantity judgment Ncold.

Under a condition of room temperature, the temperatures of the parts of fixation unit **10** at times t**20**, t**30** respectively in FIGS. **13**A and **13**B are equal to one another. Once print controller **20** receives the print request while in this state, print controller **20** makes heat controller **21** start to perform the heat control on fixation roller **12**, and to heat fixation roller **12**. Heat controller **21** detects that compensation temperature Tamb is lower than changeover temperature Tcold**1**, and sets target temperature Tsp at first target temperature Tsp**1** as the correction to target temperature Tsp. As a result, heat controller **21** controls the heating of fixation roller **12** in a way that the temperature of fixation roller **12** becomes higher than print temperature Tprn.

Once the temperature rise reaches the print start enabling temperature range at each of times t**21**, t**31**, print controller **20** starts the processes for the printing. Heat controller **21** always continues controlling the heater drive. Thereby, heat controller **21** controls the temperatures of sheet middle portions **2**LTa, **2**A**4***a* in a way that the temperatures thereof become equal to first target temperature Tsp**1**.

Heat controller **21** always continues calculating the number of printed print media as well. As a result, at each of times t**22**, t**32**, if heat controller **21** judges that the number of printed print media exceeds the number of print media for input heat quantity judgment Ncold, heat controller **21** switches the correction to target temperature Tsp to the setting of target temperature Tsp at second target temperature Tsp**2** in exchange for cancelling the setting of target temperature Tsp at first target temperature Tsp**1**. Thereby, heat controller **21** controls the temperature of fixation roller **12** in a way that the temperature thereof becomes equal to the print temperature. At this time, since the input heat quantity is sufficient, the temperature difference between middle portion **2**LTa and end portions **2**LTb of each sheet **2**LT, as well as the temperature difference between middle portion **2**A**4***a* and end portions **2**A**4***b* of each sheet **2**A**4**, already becomes sufficiently small. For this reason, after heat controller **21** switches the correction to target temperature Tsp to the setting of target temperature Tsp at second target temperature Tsp**2** in exchange for cancelling the setting of target temperature Tsp at first target temperature Tsp**1**, the temperatures of the end portions do not become lower than lower limit temperature Tlimit, either. Thus, no fixation failure occurs at each of times t**23**, t**33**.

It should be noted that the comparison between the cases illustrated in FIGS. **13**A and **13**B shows that the number of printed print media up until the cancelling of the setting of target temperature Tsp at first target temperature Tsp**1** (namely, the number of print media printed at first target temperature Tsp**1**) is smaller in the case illustrated in FIG. **13**B, namely in the case of the narrower sheet width. The reason for this is that the narrower sheet width makes the number of print media for input heat quantity judgment Ncold to become smaller. As a result, because the length of time for which target temperature Tsp is kept set at the higher value can be made shorter, the image formation apparatus is capable of making the printing with less electric power.

(Effect of Embodiment 2)

Embodiment 2 can more easily obtain the same effects as Embodiment 1 by use of the number of printed print media instead of by use of the input heat quantity.

(Modifications of Examples 1 and 2)

The invention is not limited to Examples 1 and 2 described above, and can be carried out in various utilization modes and modifications. Examples of such utilization modes and modifications include Modifications (1) to (6) as follows.

(1) The invention is applicable to a fixation unit of a different type, although Examples 1 and 2 describe a roller-type fixation unit **10**.

FIG. **14** is a schematic configuration diagram illustrating a belt-type fixation unit. Components which are the same as those in FIG. **4**B illustrating roller-type fixation unit **10** of Embodiment 1 are denoted by the same reference signs.

Belt-type fixation unit **10**A is provided with fixation belt guide **31**, pressure roller **14** and pressure pad **32** inside fixation belt **30** made of an endless belt. Once sheet **2** onto which a toner image is transferred is transported to belt-type fixation unit **10**A, pressure roller **14** and pressure pad **32** press sheet **2** against fixation roller **12** while applying pressure to sheet **2** with fixation belt **30** interposed in between. The area of the contact between fuser roller **12** and fixation belt **30** in belt-type fixation unit **10**A is larger than the area of the contact between fuser roller **12** and pressure roller **14** in roller-type fixation unit **10**. This makes belt-type fixation unit **10**A advantageous over roller-type fixation unit **10** in terms of the transferring of heat to sheet **2** while the image formation apparatus is performing high-speed printing. The use of a belt-type fixation unit **10**A like this also can bring about virtually the same working and effect as the use of the roller-type fixation unit **10** of Embodiment 1. Furthermore, the invention is also applicable to fusers whose configurations are different from those illustrated.

(2) Heat controller **21** of Embodiment 1 is designed to change the control condition for performing the temperature control on fuser roller **12** in accordance with compensation temperature Tamb, the input heat quantity, and the detected width of the sheet width. Heat controller **21** of Embodiment 2 is designed to change the control condition for performing the temperature control on fuser roller **12** in accordance with compensation temperature Tamb, the number of printed print media, and the detected width of the sheet width. However, heat controller **21** is not limited to those of Examples 1 and 2. For instance, heat controller **21** may be designed such that: heat controller **21** is provided with a timer for measuring a time length of print duration for which the image formation apparatus continues making printing since starting the printing; and heat controller **21** changes the control condition for performing the temperature control on fuser roller **12** in accordance with compensation temperature Tamb, the time length of print duration, and the detected width of the sheet width.

(3) In Examples 1 and 2, fuser heater **13** is the halogen lamp. However, fuser heater **13** is not limited to the halogen lamp. For instance, a plane heater made of resistance elements may be used as fuser heater **13**.

(4) In Examples 1 and 2, compensation thermistor **27** is attached to the position of support member **11** to which non-contact thermistor **26** is attached, in the way that compensation thermistor **27** and non-contact thermistor **26** are integrated into the single unit. However, the attachment

position and method of compensation thermistor **27** is not limited to those of Examples 1 and 2. Unlike non-contact thermistor **26**, compensation thermistor **27** may be attached to an arbitrary position which enables compensation thermistor **27** to detect the temperature of support member **11**.

(5) Examples 1 and 2 explain that the first and second temperature detectors are the thermistors. However, the temperature detectors are not limited to the thermistors. For instance, posistors or the like which exhibit characteristics opposite to those of the thermistors in terms of the change in resistance value relative to the change in temperature may be used as the first and second temperature detectors.

(6) Examples 1 and 2 cite the electrophotographic printer as the image formation apparatus. Nevertheless, the invention is applicable to multifunction printers (MFPs), facsimile machines, copying machines and the like as well.

The invention includes other embodiments in addition to the above-described embodiments without departing from the spirit of the invention. The embodiments are to be considered in all respects as illustrative, and not restrictive. The scope of the invention is indicated by the appended claims rather than by the foregoing description. Hence, all configurations including the meaning and range within equivalent arrangements of the claims are intended to be embraced in the invention.

What is claimed is:

1. An image formation apparatus comprising:

a heater;

a fixation unit provided to be heated by the heater and thereby fix an image attached on a print medium onto the print medium;

a first temperature detector provided to detect a temperature of a vicinity of the fixation unit and output a first detection temperature;

a second temperature detector provided to detect a temperature of a place which is different from that of the first temperature detector, and output a second detection temperature;

a medium width detector provided to detect a width of the print medium and output a detected width; and

a heat controller configured to obtain a temperature of the fixation unit based on the first and second detection temperatures and to control the temperature of the fixation unit based on the obtained temperature of the fixation unit and a target temperature, wherein

under a predetermined condition, the heat controller controls the temperature of the fixation unit by setting the target temperature at a first target temperature, and

if a quantity of heat supplied to the fixation unit exceeds one of a first threshold and a second threshold for a heat quantity judgment set based on the detected width while controlling a drive of the heater based on the first target temperature and the temperature of the fixation unit, the heat controller replaces the first target temperature with a second target temperature which is lower than the first target temperature, and continues fixing the image onto the print medium,

wherein the first threshold is set by the heat controller when the detected width of the print medium by the medium width detector is a first width and the second threshold is set by the heat controller when the detected width of the print medium by the medium width detector is a second width smaller than the first width.

2. The image formation apparatus according to claim **1**, wherein a calorific value is calculated by the heat controller and is a quantity of heat supplied to the fixation unit during a period of time of printing.

3. The image formation apparatus according to claim **2**, further comprising a number-of-printed-print-media detector configured to detect the number of printed print media that have been printed continuously since starting the printing, and output the detected number of printed print media,

wherein the calorific value is calculated in accordance with the detected number of printed print media.

4. The image formation apparatus according to claim **2**, wherein

the heat controller includes a timer configured to measure a time length of print duration for which the image formation apparatus has continuously printed the print media since starting the printing, and

the calorific value is calculated in accordance with the time length of print duration measured by the timer.

5. The image formation apparatus according to claim **1**, wherein the heater is a fixation heater.

6. The image formation apparatus according to claim **1**, wherein the fixation unit includes a roller whose heat capacity is smaller than that of a support member that supports the fixation unit.

7. The image formation apparatus according to claim **1**, wherein the fixation unit includes a fixation belt whose heat capacity is smaller than that of a support member that supports the fixation unit.

8. The image formation apparatus according to claim **1**, wherein if the second detection temperature is lower than a predetermined temperature before the image formation apparatus starts the printing, the heat controller judges that the second detection temperature satisfies the predetermined condition, and sets the target temperature at the first target temperature.

9. The image formation apparatus according to claim **1**, wherein the heat controller controls the temperature of the fixation unit such that end portions of the heater are provided with a higher calorific value than a middle portion of the heater.

10. The image formation apparatus according to claim **1**, wherein, based on the detected width, an amount of heat needed to be generated by the heater to heat the fixation unit is determined to bring a temperature of the end portions of the heater closer to a temperature of the middle portion of the heater.

11. The image formation apparatus according to claim **10**, wherein, when the detected width is determined to have increased from a previously detected width, the amount of heat needed to be generated by the heater to heat the fixation unit to bring the temperature of the end portions of the heater closer to the temperature of the middle portion of the heater is increased.

12. An image formation apparatus comprising:

a heater;

a fixation unit provided to be heated by the heater and thereby fix an image attached on a print medium onto the print medium;

a first temperature detector provided to detect a temperature of a vicinity of the fixation unit and output a first detection temperature;

a second temperature detector provided to detect a temperature of a place which is different from that of the first temperature detector, and output a second detection temperature;

a medium width detector provided to detect a width of the print medium and output a detected width;

a number-of-printed-print-media detector provided to detect the number of printed print media that have been printed continuously since starting the printing, and output a detected number of printed print media; and

a heat controller configured to obtain a temperature of the fixation unit based on the first and second detection temperatures and control the temperature of the fixation unit based on the obtained temperature of the fixation unit and a target temperature, wherein

under a predetermined condition, the heat controller controls the temperature of the fixation unit by setting the target temperature at a first target temperature, and

if the detected number of printed print media exceeds one of a first threshold and a second threshold for a heat quantity judgment set based on the detected width while controlling a drive of the heater based on the first target temperature and the temperature of the fixation unit, the heat controller replaces the first target temperature with a second target temperature which is lower than the first target temperature, and continues fixing the image onto the print medium,

wherein the first threshold is set by the heat controller when the detected width of the print medium by the medium width detector is a first width and the second threshold is set by the heat controller when the detected width of the print medium by the medium width detector is a second width smaller than the first width.

13. The image formation apparatus according to claim **12**, wherein if the second detection temperature is lower than a predetermined temperature before the image formation apparatus starts the printing, the heat controller judges that the second detection temperature satisfies the predetermined condition, and sets the target temperature at the first target temperature.

14. The image formation apparatus according to claim **12**, wherein a calorific value is calculated by the heat controller and is a quantity of heat supplied to the fixation unit during a period of time of printing.

15. The image formation apparatus according to claim **14**, further comprising a number-of-printed-print-media detector configured to detect the number of printed print media that have been printed continuously since starting the printing, and output the detected number of printed print media,

wherein the calorific value is calculated in accordance with the detected number of printed print media.

16. The image formation apparatus according to claim **14**, wherein

the heat controller includes a timer configured to measure a time length of print duration for which the image formation apparatus has continuously printed the print media since starting the printing, and

the calorific value is calculated in accordance with the time length of print duration measured by the timer.

17. The image formation apparatus according to claim **12**, wherein the heater is a fixation heater.

18. The image formation apparatus according to claim **12**, wherein the fixation unit includes a roller whose heat capacity is smaller than that of a support member that supports the fixation unit.

19. The image formation apparatus according to claim **12**, wherein the fixation unit includes a fixation belt whose heat capacity is smaller than that of a support member that supports the fixation unit.

20. The image formation apparatus according to claim **12**, wherein the heat controller controls the temperature of the fixation unit such that end portions of the heater are provided with a higher calorific value than a middle portion of the heater.

21. The image formation apparatus according to claim **12**, wherein, based on the detected width, an amount of heat needed to be generated by the heater to heat the fixation unit is determined to bring a temperature of the end portions of the heater closer to a temperature of the middle portion of the heater.

22. The image formation apparatus according to claim **21**, wherein, when the detected width is determined to have increased from a previously detected width, the amount of heat needed to be generated by the heater to heat the fixation unit to bring the temperature of the end portions of the heater closer to the temperature of the middle portion of the heater is increased.

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